CURSUS MATHEMATICUS.

BOOK VI.

Containing the

DESCRIPTION and USE

OF

Geometrical Instruments:

AND THE

DOCTRINE

OF

PLAIN (or Right-Lined) TRIANGLES,

Applied to Practice.

IN THREE PARTS

I. In *Longimetria*; or, The Measuring of Heights and Distances; and in the Describing of Cities, Towns, *&c.*

II. In *Planometria*; or, The Surveying of Land divers ways, and finding the Content or Quantity of the same.

III. In *Military Architect*, or *Fortification*; and to find the Lengths and Quantities of all the Lines, Angles, and other Members of a Fort, and the Out-Works belonging to the same, by *Trigonometrical Calculation.*

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THE DESCRIPTION and USE OF *GEOMETRICAL INSTRUMENTS*, And the DOCTRINE of PLAIN (or Right-Lined) TRIANGLES, Applied to PRACTICE IN LONGIMETRIA, Or in the Measuring of Heights and Distances.

PART I.

CHAP. I.

A Description of such Instruments *as are necessary for the Performance of the Works following.*

BEfore I come to apply the *Doctrine* of Right-lined *Triangles* to Practice, in the taking of *Heights*, *Depths*, *Distances*, *&c.* and in *Surveying* of *Land*; it will be necessary to describe what *Instruments* are most proper for those purposes, and the general Uses of them.

The Instruments are,

1. *Compasses.*
2. A *Ruler* of Brass, or Wood, with a *Diagonal Scale*, and divers *Plain Scales* of *Equal Parts*, and two or three Scales of *Chords*.
3. A *Protractor* and *Protracting Pin*.
4. A *Quadrant* for *Altitudes* or *Descents*.
5. A *Theodolite*, with its Appurtenances, for *Distances*, and *Surveying* of *Land*.
6. *Measures* to Measure withal.

SECT. I. Of the Compasses.

COmpasses are so well known to all Men, that it may seem superfluous to say any thing concerning them: But the *Compasses* fit for these and such like Purposes, are of two sorts, both of them of *Brass*, with *Steel Points*, but one Pair to have three Movable *Points*, to take in and out of a Nut in one of the Legs for that purpose provided, and a Screw to keep the Point fast in.— — One of the Movable Points is in all respects answerable to the other Fixed one; but the other two are different; the one being hollow, to put a Black lead Pencil in; and the other is a Steel Pen, to be used with Ink. And so much concerning *Compasses*: I need say nothing concerning the Use of them, it being sufficiently known to all; but see that your Points be of good Steel, and sharp; and that the Joint move evenly, and not by Starts.

SECT. II. Of the Scales, their Description and Use.

The Description.

Fig. I. YOur *Scale* may be made either of *Silver*, *Brass*, *Ivory*, or *Box*, of what length or breadth you please; but a convenient length will be eight or nine Inches, and in breadth one Inch and a quarter.

On one side thereof let be placed divers *Scales* of *Equal Parts*, as of 10, 11, 12, 16, 20, 24, and 30 in an Inch.

¶ *Note*, That when I say, a Scale of 12 in an Inch, you are to understand a Part of a Line divided into 10 Equal Parts, 12 of which Parts will make a just Inch; and the like of 16, 24, &c.

On the same Side of the Ruler let be placed two or three *Scales* of *Chords*, of several lengths, extended up to 90 *deg*.

On the other side of the Ruler let there be two *Diagonal Scales*, one of an *Inch*, the other of *Half an Inch*; out of which you may very accurately take the hundredth Part of an Inch or half an Inch.

The Use of the Scales.

The Use of these Scales is two fold, *viz*. (1.) To *lay down* any *Measure* taken; or, (2.) A Line being *laid down*, To find how much of that *Measure* that Line containeth.

I. *A* Distance *measured, how to lay down the same upon* Paper *according to any* Scale.

Suppose that measuring upon the Ground, you have measured 62 Foot, Yards, Fig. II. Perches, or any other Measure whatsoever; and you would lay this Line down upon Paper, by the Scale of 12 in an Inch. First, draw a Right Line, as A B, and then with your Compasses set one Foot upon 6, (in the Scale of 12,) which now represents 60, and extend the other Foot to two of the smaller Divisions in the uppermost subdivided Part, which Distance set upon the Line A B from A to C: So shall the Line A C represent 62 Foot, (or any other Measure,) it being laid down by the *Scale* of 12.

But if you would have your Line shorter, and yet to contain 62; then use some other of your *Scales*, as that of 16 in the same manner; and then 62 will reach from A to D: And if you would have it yet shorter, take it from the *Scale* of 24, and it will reach to E; or from the *Scale* of 30, and it will reach to F.

II. *A Right Line (of any Measure) being laid down, to find how much it containeth of that Measure, according to any Scale.*

Suppse A C were a Line laid down, and it were required to know how many Feet it contained according to the *Scale* of 12.

Take the Length of the Line A C in your Compasses, and applying it to the *Scale* of 12, you shall find it to reach from 6 (or 60) to two of the small Divisions in the uppermost

uppermost sub-divided Part, which makes it 62: And so much doth the Line A C contain by the *Scale* of 12. Also,

The Line {A D, A E, A F} will be found to contain 62, being applied to the Scale of {16. 24. 30.}

Again, If it were required to know how many Yards the Line A B will contain, if measured by the *Scale* of 12.

Take the Line A B in your Compasses, and applying that Distance to the *Scale* of 12, you shall find it to reach from 6 (or 60) to 9 and a half of the small Divisions, shewing that the Line A B contains 69 Yards and a half, according to the *Scale* of 12.—— And if the same Line were measured by the *Scale* of 16, it would be found to contain 92 and a half.——Or by the *Scale* of 24, it would be 139 Yards, *&c.*

Concerning the *Diagonal Scales* on the other side of the Ruler, they serve to the same Use as the other *Plain Scales* do, only you may take off accurately the hundredth part of any Measure.—— *Example.* Suppose you were to take off 284 of any Measure,—— Count the 2 upon the great Figures on the Left-hand side of the *Ruler*, and the 8 on the smaller Figures on the same Left side, where the *Diagonal Lines* are drawn, and the 4, from 2 of the upright Lines on the Left side; and that Distance will contain 284 Feet, Yards, or any other *Measure*. And this Distance being taken from the *Diagonal Scale*, will reach upon the former Line A B, from A to S.

Of the Scales of Chords.

Upon the same side of the Ruler where the *Plain Scales* are, there are two or three *Scales* of *Chords*; the Description and Making whereof you may find in Book II. Part II. Chap. II. And the Uses of these *Scales* of *Chords* are principally two, *viz.* (1.) To lay down an *Angle* containing any *Quantity*: Or, (2.) An *Angle* being laid down, to find the Quantity thereof.

I. *To lay down upon Paper an* Angle *containing any Number of Degrees and Minutes required.*

Draw a Line at pleasure, as A B, and upon the Point A, let it be required to *Protract* an *Angle* to contain 32 *deg.* 30 *min.* or $32\frac{1}{2}$ Degrees. *Fig.* III.

First, Place one Foot of your Compasses upon the beginning of any of your *Scales* of *Chords*, and extend the other Foot, always, to 60 Degrees: Then setting one Foot of the Compasses upon the given Point A, with the other describe the Arch *e d*: Then setting one Foot of the Compasses in the beginning of the *Scale* of *Chords*, extend the other to 32 *deg.* 30 *m.* and set that Distance upon the Arch from *e* to *d*: Then from the Point A draw the Line A C, through the Point *d*: So shall the *Angle* D A C contain 32 *deg.* 30 *min.*

II. *An* Angle *being already laid down, to find the* Quantity *thereof.*

Let the *Angle* already laid down be the Angle C A B whose Quantity is required. *Fig.* III.

Open your Compasses from the beginning of any of your *Scales* of *Chords*, to 60 Degrees; then setting one Foot in the Angular Point A, with the other describe the Arch *e d*, (between the two Sides containing the *Angle*:) Then take the Distance between *e* and *d*, which measure upon the same *Scale* of *Chords*, from the beginning of it, and it will reach to 32 *deg.* 30 *m.* which is the Quantity of the *Angle* C A B.

If an *Angle* given, or required, shall exceed 90 *deg.* you must set it off upon the Arch-line at twice: As if you were to lay down an *Angle* of 159 *deg.* Having described your Arch-line far enough, your *Compasses* standing at 60 *deg.* set that distance twice upon the Arch-Line, from E to *f*, and from *f* to *g*, so there will be 120 *deg.* then from your Scale take the remaining Degrees; namely 39, and set them on farther upon the Arch-Line from *g* to *h*, and through *h* draw the Line A D: So shall the *Angle* B A D contain 159 *deg.*

SECT. III. *Of the Description and Use of the* Protractor.

I. *Its Description.*

Fig. IV. THIS Instrument consisteth of two Parts; the one a *Semicircle* divided into Degrees, the other a *Parallelogram*, with *Scales* upon it. The *Instrument* ought to be made of a piece of thin Brass, well pollished, and the Edges thereof very smooth; for the bigness, it may be about 4 or 5 Inches, and the breadth of the *Parallelogram* about an Inch and half.—— For the *Semicircle*, let it be divided into two *Quadrants* in the Point G, by the Perpendicular H G. Divide each *Quadrant* into 90 deg. and so the *Semicircle* into 180 deg. which let be numbred from E by 10, 20, 30, &c. to 180, ending at F. And the same way also (in another Margine) from 180 to 360, as you see done in *Figure* IV. so that there needs no farther Description of this Instrument.

II. *Its Use.*

The Uses of this Instrument may be performed by the *Scales* of *Chords* last treated of; but where many *Angles* are to be laid down, (as in *Surveying of Land*,) this *Protractor* is far more convenient: And its Uses are principally two, *viz.* (1.) To lay down an *Angle* of any assigned quantity of Degrees. Or, (2.) An *Angle* being *Protracted*, to find the quantity of Degrees that it containeth.

I. *How to* Protract *(or lay down upon Paper) an* Angle *containing any number of Degrees required.*

Let a Line be drawn at pleasure, as the Line B A E, and upon the Point A let it be required to Protract two *Angles*, from the Line B A; one to contain 32 *deg.* 30 *min.* and the other 159 *deg.*

First, Put your *Protracting Pin* in the given *Point* A, to which Point also bring the Centre of your *Protractor* H, turning it about upon the Centre-pin, till the Line E F of the *Protractor* do lie directly upon the Line B A E, the Centre H upon the Point A.

Secondly, Keeping the *Protractor* in this position, fast down to the Paper, with your left Hand, take out your *Protracting Pin*; and, because the two *Angles* to be protracted are 32 *deg.* 30. *m.* and 159 *deg.* count 32. *deg.* 30 *m.* upon the Limb (or Edge of your *Protractor*) from E, and you shall find it to end at *k*. Against which make a small mark upon the Paper at *k*. Also the other *Angle* being 159 *deg.* count them from E as before, and they shall end in *l*. where make a mark upon the Paper.

Lastly, Take away the *Protractor*, and from the Point A, and through the mark *k* draw the Line A *k* C.—— Also from the Point A, through the mark *l*, draw the Line A *l* D; so shall the *Angle* C A B contain 32 *deg.* 30 *m.* and the *Angle* B A D 159 Degrees.

II. *An* Angle *already laid down, or* Protracted, *to find the Quantity thereof.*

Let C A B, and B A D be two *Angles Protracted*, and let the quantities of each of them be sought by the *Protractor*. Apply the Centre H of the *Protractor* to the Angular Point A, and the Line E F upon the Line B A E; then shall you find the Line C A, to lie under 32 *deg.* 30 *min.* and the Line A D under 159 *deg.* and those are the quantities of the two *Angles* B A C 52 *deg.* 30 *min.* and B A D 159. *deg.*

But if it were required to find the quantity of the *Angle* C A D, apply the Centre of the *Protractor* H to the Point A, and the Line E F thereof upon the Line C A; so shall the Line A D lie just under 126 *deg.* 30 *min.* and that is the quantity of the *Angle* C A D.

SECT.

SECT. IV. *The Description of a* Quadrant, *for the taking of* Altitudes *or* Descents.

THIS *Instrument* may be made of Brass or Wood, and of what bigness you please, about 16 or 18 Inches is a competent size: the Limb whereof must be divided into 90 equal Parts or Degrees; and those again subdivided into as many Parts as the bigness of the *Quadrant* will permit, each Part containing 5, 6, or 10 *min.* Or, the Limb may be made broad, and so divided by *Diagonals* to express every single *minute.*—— On the back-side of the *Quadrant* may be a *Ball-Socket* to set the *Quadrant* either *Horizontal* or *Vertical:* And upon the upper Edge are placed two Sights, through which to look to behold any *Object*; and in the Centre is fixed a small Silk String, with a *Plummet* at the end thereof: And these are all the *Members* or *Parts* belonging to this *Instrument*. *Fig.* V.

For its *Use*, it is principally to take *Angles* of *Altitude*, as of the *Sun*, *Moon*, *Stars*, or of any *Tower*, *Steeple*, &c. upon the *Land*, as by *Examples* following shall appear. In the mean time view the *Figure* of the *Instrument*, with all its Parts put together; with the manner how it is to be used.

SECT. V. *Of the* Theodolite, *and its Appurtenances; the Description thereof, and to what* Uses *it principally serveth.*

THIS *Instrument* consisteth of several *Parts* or *Members*; As,

The first and principal part is a *Circle* of *Brass* or *Wood*, divided first into four *Quadrants*, representing the four Cardinal Points of the Campass *East*, *West*, *North*, and *South*, and therefore are noted with the Letters N. S. W. E.—— Each of these *Quadrants* is divided into 90 *deg.* and sub-divided according as the bigness will permit: or by *Diagonals*, as the *Quadrant* before. —— These four *Quadrants* are to be numbered by 10, 20, 30, &c. both ways, beginning at the *North* and *South* Points, and ending with 90 at the *East* and *West* Points. *Fig.* VI.

The second *Part* or *Member* is a *Box* and *Needle*, so conveniently contrived, to stand upon the *Centre* of the *Circle*; upon which *Centre*, the *Instrument*, the *Index*, with its *Sights*, must be made to turn about, and yet both the *Instrument*, and the *Box*, and *Needle* remain fixed —— At the bottom of the *Box* there must be a *Card*, or *Mariners Compass* fixed, answerable to the Letters E. W. N. S. upon the *Instrument*.

The Third *Member* is a *Socket* on the back-side (either Plain or with a Ball) to be put upon the head of a Three Legged Staff.

The Fourth *Member* or *Part* is a *Staff* to set the *Instrument* upon; the Neck, at the Head whereof, must be made to go into the *Socket* on the back-side of the *Instrument*: For better satisfaction view well the *Figure* of the *Instrument*, with all its Parts put together, and the manner how it is to be handled.

SECT. VI. *Of* Measures, *to measure withal.*

MEasures are many; but some are more commodious for one purpose than others: therefore I will only name some few, and for what Uses they are fittest to be applied.

1. The first and shortest is a *Rod of Ten Foot* in length, and each Foot divided into 10 Parts. And such a Rod is most convenient to measure any Height or Distance under 100 Foot.
2. A *Chain of* 100 *Foot* long, each *Link* being *one Foot* in length; and at each 10 Foot let there be a *Plate* of Brass, with a *Figure* engraven thereon, to shew readily how many Feet are from the beginning of the *Chain:* And for the more ease in accounting, let there be a *Brass Ring* at every five Links, that is, one between every two *Plates*. This *Chain* is most commodious for measuring of *Large Distances* or *Lengths*.

3. A *Chain* of 16 Foot and a half in length, and to contain 100 Links, with *Rings* at every tenth Link: Which will be good to measure small *Garden-grounds*, or *Orchards*, by *Pearch* or *Pole* measure.
4. A *Chain* of *Four Pole* or *Perches* in length, which is 66 Foot; which *Chain* let consist also of 100 Links, with *Plates* and *Rings*, as in the other before, for ease in accounting. This *Chain* of all others is the most commodious for *Land-measure*, as will appear hereafter.

CHAP. II.

Of Altimetria, *or the taking* Heights.

THE Object whose Altitude you desire to measure, may be either *Accessible* or *Inaccessible*: It may stand upon *Level Ground*, or upon a *Hill*; or be otherwise seated. Examples of several kinds.

SECT. I. *To take an* Accessible Altitude *at one* Station.

Fig. VII. LEt A be a *Tower* or other *Edifice*, standing upright, upon Level Ground: And let the Height thereof be required to be known, you standing at B.

1. Set your *Quadrant*, it being upon its Staff, at your Place of Standing B, and turn it in the Socket, so that the Thred, with the Plummet at the end thereof, may play freely by the side of the *Quadrant*: Then elevate the *Quadrant* upwards or downwards (as occasion requires) till through the *Sights* of the *Quadrant* you see the very top of the Battlements at S; and there keeping the *Quadrant* fast, (by means of a Screw for that purpose,) observe what Degrees and Minutes on the *Quadrant's* Limb are cut by the Thred, (suppose 35 *deg.* 20 *min.*) which note down.

2. Then (the *Quadrant* still being in this Position) extend a Line (or Cord) from the *Quadrants* side where the Sights stand, till it touch the Ground at C, and there make a Mark.

3. Measure with your *Rod* (or *Chain*) the Distance from C to T, the Foot of the Tower, which suppose to be 103 Foot and 4 tenth parts of a Foot; which also set down: And now you are prepared to find the Altitude of the *Tower* S T, by *Trigonometrical Calculation*.

4. For by *Figure* VII. you may perceive, that the *Tower* S T, standing Perpendicular upon the Plain Ground T C, and the *Visual Line* C S, made by observing the top of the Building at S, do make a *Right-angled Triangle* S T C; in which you have given,

1. The Angle at C, 35 *deg.* 20 *min.* which were the Degrees of the Quadrant cut by the Thred at C.
2. The Side T C, measured by the *Rod* or *Chain*, 103.4 Foot.
3. The Right Angle at T, for that the *Building* is perpendicular to the *Ground*.

Wherefore, by the I. *Case* of Right-angled Plain Triangles, say,

$$\begin{array}{lcccccc} \textit{As}\ \text{c s C, } \textit{viz.}\ \text{S} & : & \text{T C} & :: & \text{s C} & : & \text{S T.} \\ 54^d\ 40^m & : & 103.4 & :: & 35^d\ 20^m & : & 73.3. \end{array}$$

Which 73.3 Foot is the Height of the *Tower* required.

In like manner might the *Hypotenuse* be found, by the II. *Case*. For,

$$\begin{array}{lcccccc} \textit{As}\ \text{TSC} & : & \text{TC} & :: & \textit{Rad.} & : & \text{S C.} \\ 54^d\ 40^m & : & 103.4 & :: & 90^d & : & 126.7. \end{array}$$

SECT.

SECT. II. *How to take an Inaccessible* Altitude *at two Stations.*

LEt A B be a *Church Steeple*, and let it be required to find the Height thereof, you being at C, between which Place and A, the bottom of the Steeple, there is a River, so that it is inaccessible. *Fig.* VIII.

First, Set up your *Quadrant* at C, and move it up and down, till through the Sights you see the top of the Spire at B, noting what Degrees are cut by the Thred upon the Quadrant, which suppose 27 *deg.* 30 *min.*

Secondly, Measure from C towards A, so far as you can in a Right Line, as suppose to D, 92.7 Foot.

Thirdly, At D set up your Quadrant again, and move it up and down, till you see the top of the Spire at B, and note what Degrees are then cut by the Thred upon the Quadrant, which suppose to be 52 *deg.* 30 *min.*

Fourthly, By these two Observations at C and D, and the measured Distance C D, the Altitude of the Steeple may be found: For the two Visual Lines through the Sights at C and D, together with the measured Distance D C, do make the Oblique-angled Triangle A D C; in which is given,

1. The Angle A C D, 27 *deg.* 30 *min.*
2. The Side C D, 92.7 Foot. And,
3. By the Angle observed at D, 52 *deg.* 30 *min.* also you have the Angle B D C, 127 *deg.* 30 *min.* it being the Complement of 52 *deg.* 30 *m.* to 180 *deg.* And,
4. Having the two Angles B D C, 127 *deg.* 30 *min.* and the Angle B C A, 27 *deg.* 30 *min.* their Sum is 155. You have also the Angle D B C given, 25 *deg.* it being the Complement of 155 to 180.

And thus in the Triangle A D C, having the three Angles, and one Side D C given, you may find the Side B D, by *Case* I. of Oblique-angled Plain Triangles. For,

$$\textit{As}\ s\,DAC \ :\ DC\ ::\ s\,ACD\ :\ AD.$$
$$25^{d}\,0^{m}\ :\ 92.7\ ::\ 27^{d}\,30^{m}\ :\ 101.3.$$

Then again in the Triangle A B D, Right-angled at B, you have given the *Hypotenuse* A D 101.3, and the Angle at the Base B D A, 52 *deg.* 30 *min.* to find the *Perpendicular* A B: Which by the II. *Case* of *Right-angled Triangles*, may be thus found.

$$\textit{As}\ R\ :\ AD\ ::\ s\,BDA\ :\ BA.$$
$$90\ :\ 101.3\ ::\ 52^{d}\,30^{m}\ :\ 80.3.$$

SECT. III. *How to take the Altitude of a* Tower, Steeple, Beacon, *or the like, which standeth upon a* Hill.

LEt H K be a *Beacon* standing upon a Hill, and you, standing at L, desire to know the Height thereof above the *Hill*. *Fig.* IX.

First, Place your *Quadrant* at L; then looking through the *Sights* till you see the top of the *Beacon* at H, you find the Thred to cut 40 *deg.* of the Quadrant: And at the same Station you look through the Sights to K, the Foot of the Beacon, and find the Thred there to cut 22 *deg.* 3 *min.*

Secondly, Removing your Quadrant to O, and there looking through the Sights, till you see the top at H, you find the Thred to cut 60 *deg.* and looking to K the bottom, you find it to cut 39 *deg.* 54 *min.*

Thirdly, Measure the *Distance* O L, which you find 132 Foot, all which note down So in the Triangle H O L you have given,

1. The Angle H L O, 40 *deg.*
2. The Angle H O L, 120 *deg.*
3. The Distance O L, 132 Foot, by which the Side H O may be found 248, by the I. *Case* of *Oblique-angled*, and the whole Height H M, 214, by the I. *Case* of *Right-angled Triangles*; in all respects as the Height B A was found in the last *Section* before-going, and will be found to be 214 Foot.

Having thus found the whole Height H M 214, you have in the Right-angled Triangle H M O, given,

1. The

1. The Perpendicular H M, 214 Foot.
2. The Angle at the Base, H O M, 60 *deg.*

To find the Base M O. Which may be found by the IV. or V. *Cases* of *Right-angled Triangles*, thus.

As s H O M : H M : : s M H O : M O
60 d : 214 : : 30 d : 124.

And thus have you the whole Height M H 214, and the Distance O M 124. And so in the Right-angled Triangle K M O, you have given,

1. The Distance M O, 124 Foot.
2. The Angle K O M, observed at O, 39 *deg.* 54 *min.* whose Complement 50 *deg.* 6 *min.* is the Angle M K O.

By which you may find K M, by the I. *Case* of *Right-angled Triangles.*

As s M K O : M O : : s K O M : K M
50 d 6 m : 124 : : 39 d 54 m : 103.7.

Which 103.7 is the Perpendicular Height of the Hill; and being subtracted from 214, the whole Height H M, leaves 110.3, for the Height of the Beacon H K above the Hill.

SECT. IV. *How to find the* Horizontal *Line of a* Hill.

Fig. X. THis is a right necessary thing to be known, especially in *Surveying* of Land, where the Length of the Sides of the Hill is not required, but the Base Line upon which the Hill standeth.

In your Survey, suppose you should meet with such a *Hill* or *Mountain* as this, noted with M.

First, Place your *Quadrant* upon its Staff at the Foot of the Hill at D; then let one go to the top of the Hill at C, and there set up a Mark, which must be so much above the top of the Hill, as the top of the *Quadrant* is from the Ground: Then move the *Quadrant* up and down, till you see the top of the Mark at C, and note what Degrees of the *Quadrant* are cut by the Thred; which suppose 47 *deg.* Then measure up the *Side* of the *Hill*, from D to C, which let be 235 Foot.

Secondly, Remove your *Quadrant* from D to C, and there set it up, as before. Now (because there is a Level at the top of the Hill, from C to B,) measure the Length thereof, which suppose to be 122 Perches, and at B let a Mark be set up, of such height from the Ground as your *Quadrant* is.

Thirdly, Plant your *Quadrant* at B, and let one go to the Foot of the Hill at A, and there erect a Mark of equal height with your *Quadrant* at B; and through the Sights look down till you see the top of the Mark at A, observing what Degrees of the Quadrant are cut by the Thred, which suppose 46 *deg.*

Fourthly, Measure down the Descent of the Hill from B to A, which let be 253 Foot. Now by these two *Observations* made by your *Quadrant*, and the three Distances measured, you may lay them down upon Paper, and so shall you have constituted Two *Right-angled Plain Triangles*, and a *Parallelogram*; *viz.* the Triangles C F D, and B E A, and the Parallelogram B C F E; and from what is given in these *Triangles* and the *Parallelogram*, you may find the *Base Line* of the *Hill* A D: For,

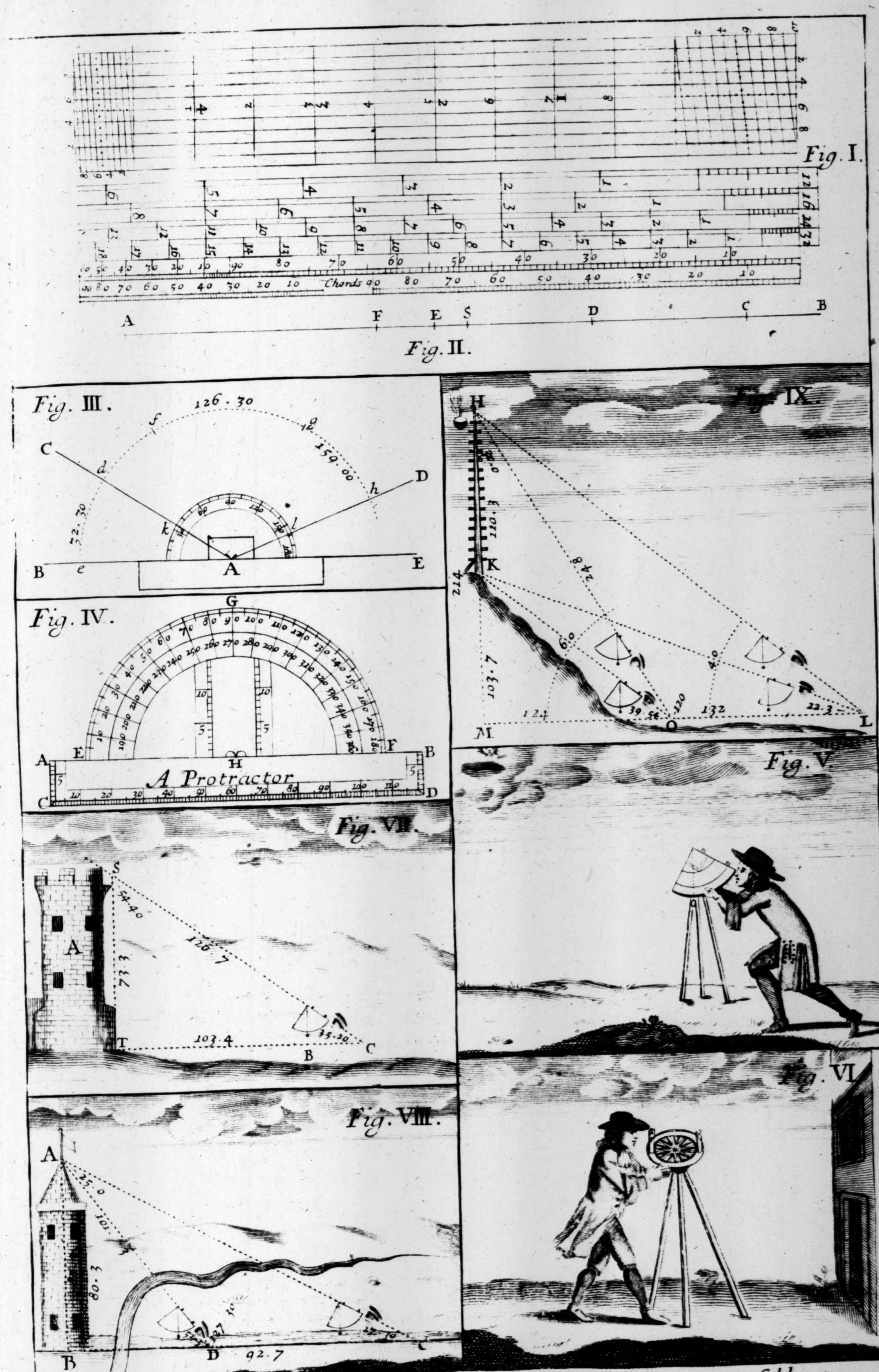
First, In the Triangle C F D, you have given, (1.) The *Angle* C D F (observed by your *Quadrant* at D) 47 *deg.* (2.) The *Side* of the Hill C D measured 235 *Perches.* And (3.) The *Angle* F C D (the complement C D F) 43 *deg.* To find the *Base* F D.

By the III. *Case* of the Right-angled Triangles.

As R : C D : : s F C D : F D.
90 d : 235 : : 43 d : 160.

Then in the *Parallelogram*, you have given the top of the Hill measured from B to C 122 *Perches*: to which E F is equal.

And



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And in the *Triangle* A E B, you have given, (1.) The *Angle* A B E (observed by your *Quadrant* at B) 46 *deg.* (2) The *Hypotenuse* (or side of the *Hill* measured B A) 253 *Perches.* To find the *Base* A E.

By the III. *Case* of Right-angled Triangles.

As R : A B : : s A B E : A E.
90^d : 253 : : 46^d : 182.

Which three Numbers 160, 122, and 182 added together, do make 464 for the whole *Base* of the *Hill* A D.

CHAP. III.

Of Longimetria, *or the taking of* Distances

As the *Quadrant* was the most convenient *Instrument* for the taking of *Altitudes*, so the *Theodolite* is the best for taking of *Distances* of *Trees*, *Steeples*, *Towers*, &c. either of *one* or *many* together: Of which here shall follow several Examples.

SECT. I. *To Measure one single* Distance.

Let C be a *Tree*, standing in a *Field* by it self, and you being at A, (either in that *Field* or some other, it mattereth not, so you be but within convenient sight of it) and you are desired to know the Distance to that *Tree*, without approaching nearer to it than you are at A. *Fig.* XI.

First, Set up your *Theodolite* upon its *Staff* at A, as Level (or Horizontal) as you can, laying the *Index* with *Sights* upon it on the *North* and *South Diametre* of the *Instrument*.

Secondly, Turn the *Instrument* about the *Socket*, (the Index and Sights still lying upon the Diametre,) till through the Sights you see the *Tree* at C; which when you do, fix the *Instrument* to the Socket with the Screw.

Thirdly, From the Foot of your *Instrument* at A, Measure with your Rod or Chain, any number of Feet, Yards, or the like, any way; as from A to B 100 Foot: and there cause a Mark or Staff to be set up.

Fourthly, Turn the *Index* and *Sights* about upon the *Theodolite*, till through them you see the *Mark* set up at B; and note what Number of *deg.* and *min* the *Index* cuts; which let be 120 *deg.* 10. *min.* which set down.

Fifthly, Then set up some visible *Mark* at A, where the *Instrument* stood, and remove the *Theodolite* to B, and then setting it up, with the *Index*, upon the North and South Diametre, as before, turn the *Instrument* about, till through the *Sights* you see the *Mark* set up at A; and there fix it.

Sixthly, Turn the *Index* about till through the *Sights* you see the *Tree*, and note what Degrees the *Index* cuts upon the *Instrument* from the North and South Diametre, which let be 50 Degrees: which note down, and so have you done your work in the Field.

And now to find the distance from A, or from B to the *Tree*, you may see that the *Tree* at C, and the two Stations or Mark at A and B, do make an *Oblique Angled Triangle* A B C, in which is given,

1. The Angle C A B 120 *deg.* 10 *min.* observed at the first Station A.
2. The Distance Measured A B 100 Foot.
3. The Angle C B A, observed at the Second Station at B, 50 *deg.*

By which you may find the *Distances* A C and B C, by the I. and II. *Cases* of *Oblique angled Plain Triangles.* For,

Having the two Angles at A 120 *deg.* 10 *min.* and at B 50 *deg.* their Summ is 170 *deg.* 10 *min.* which taken from 180 *deg.* there remains 9 *deg.* 50 *min.* for the Angle at C.

Then

Then by *Case* I.

As sBCA	:	AB	::	sCBA	:	AC.
$9^d 50^m$	:	100	::	$50^d 0^m$	:	448.6

And by *Case* II.

As CBA	:	CA	::	*comp.* CAB	:	CB
$50^d 0^m$	:	448.6	::	$59^d 50$	:	506.2

So the *Distance* from A to C is 443.6 Foot; and from B to C 506.2 Foot.

SECT. II. *How to take the* Distances *of divers things remote from you; As* Churches *and* Publick Halls *in a City: A* Camp *upon a* Heath, *a* Squadron *of* Ships *at Sea, or such like. And to make a* Map *or Draught of the same: With a* Scale *to Measure the* Distance *of any* Place *to any other therein described.*

Fig. XII. SUppose that A, B, C, D, E, and F, were a *Squadron* of *Ships* lying at *Anchor*, and you being on shore, and desired to make a Draught of them, representing their Situation and true Distance one from another.

I. *For the Observation made upon the Shore.*

Seek out two convenient places upon the Shore, from either of which you may see all the Ships at one view, and make those two Places your two Stations for Observation, as N and S. Then,

First, Set up your *Theodolite* at N upon its Staff, very firm and level.

Secondly, Turn it about upon the Socket, till the Needle hang directly over the *Meridian Line* of the Card, in the bottom of the *Box*, the North end of the Needle, over the *Flower de luce*: and then screw the Instrument fast. Your *Instrument* being thus fixed at N, call that your *First Station*; and turn the *Index* about, till through the Sights, you see the first *Ship* A, and note what Degrees of the *Theodolite* the *Index* cuts, as 60 *deg.* which note down —— Then turn the *Index* about, till through the *Sights* you see the Ship at B, and mark what Degrees are cut by the *Index*, as 74 *deg.* 30 *min.* and note them down. —— Doe thus with all of them, be there never so many.

Then Measure the Distance between N, your *First Station*, and S, your *Second Station*; which is 220 *Perches*: And bring your *Theodolite* from N to S, and there set it up, firm and level, as before at N; and laying the *Index* upon the North and South Diametre, turn it about till through the Sights you see your *First Station* at N: and then fix it.

Then turn the *Index* about, till through the Sights you see the first Ship at A, and note what Degrees the *Index* cutteth; which suppose 31 *deg.* 30 *min.* which note down —— Then turn the Index about to B, C, D, *&c.* noting the Degrees cut by the *Index* at every moving; and set them down in a *Table* ruled for that purpose, as is here done in this Example.

		At the First Station, the *Index* cut			At the Second Station, the *Index* cut	
		De.	M		De.	M
	A	60	00		31	30
	B	74	30	Stationary Distance, 220 Perches.	38	40
At	C	84	30		43	20
	D	104	50		54	00
	E	117	00		68	10
	F	145	10		97	00

II. *How*

II. *How to* Protract *or lay down upon* Paper, *the* Observations *last taken.*

Upon a Sheet of large Paper or Parchment draw a Line at length, as O P; upon which assume any Point (as N) for your first *Station*; unto which Point apply the Centre of your *Protractor* H, and lay the Line E F of the *Protractor* just upon the Line O P. *Fig.* XII.

Then keeping the *Protractor* in that Position, lay your *Table* of *Observations* before you, count 60 deg. (the first *Observation* you made to the Ship A) upon the edge of the *Protractor*; against them make a mark, with your *Protracting Pin*, upon the Paper: then count 74 deg. 30 min. upon the *Protractor*, and against them make a mark with your Pin, as before: Also do the like with 84 deg. 30 min. 104 deg. 50 min. &c. till you have pricked down all your *Observations* made at your *first Station* at N.

Then taking off your *Protractor*, draw obscure Lines from N, through those marks, as the Lines N A, N B, N C, &c.

Then out of some *Scale* of equal Parts (answerable to the bigness you intend your *Plot*,) take off 220 *Perches*, and set them upon the Line O P, from N to S.

Unto the Point S apply the Centre of your *Protractor*, laying the Diametre E F thereof upon the Line O P; where keeping the *Protractor* in that Position, lay your *Table* of *Observations* at your second *Station* before you; and with your *Protracting-Pin* make marks at 31 deg. 30 min.. your first *Observation*, and at 38 deg. 40 min. your *second*, at 43 deg. 20 min. the *third*, &c. till you have pricked down all your *Observations* made at your *second Station* at S.

Then taking away your *Protractor*, draw obscure Lines from S, through the several marks made upon your Paper, as the Lines S A, S B, S C, &c. cutting the Lines before drawn N A, N B, N C, &c. in the Points A, B, C, D, E, and F; which Points shall represent the several *Ships* as they lie at *Anchor*, every one at his true *Distance* and *Position* from another, as they do in the *Sea*, *River*, or *Harbour*: as also from either of your *Stations* N or S. And now,

III. *To make a* Scale *to Measure any* Distance *upon this* Plot.

Forasmuch as the distance between N and S was measured 220 Perches, divide a Line in such sort into Parts, as the *Scale* was divided from whence you laid down the distance N S 220; and such is the *Scale* L M in the Figure: for if with a Pair of Compasses you take the distance between N and S, if you set one Foot of that distance upon the *Scale* in the Point noted 200, the other shall reach, from thence, upon the *Scale* to 20 of the small Divisions, in the first part of the *Scale*: And the *Scale* being thus divided and numbered, you may Measure any Distance or Distances upon the *Plot*. And so you shall find the Distance

$$\text{From}\left\{\begin{array}{l}\text{N to A}\\ \text{N to B}\\ \text{A to B}\\ \text{A to S}\end{array}\right\}\text{to be}\left\{\begin{array}{r}241.9\\ 236.7\\ 61.0\\ 399.6\end{array}\right\}\text{Perches.}$$

SECT. III. *To Measure any of the* Distances, *thus laid down, by* Trigonometrical Calculation.

BY the Intersection of the several visual Lines made at both *Stations*, and constituted several *Right-lined Triangles*; in either of which you will have enough given to find whatsoever distance you shall require. *Fig.* XII.

Example 1. *Let it be required to know the distance from your Station* N, *to the first Ship at* A.

By the Visual Line N A, made at your first *Station*, and the Visual Line S A, at your second *Station*, intersecting each other in A; is constituted the *Right-lined Triangle* A N S; in which is given,

1. The Angle A N S, 120 deg. it being the Complement of the Angle observed to A, at your first *Station* (*viz.* 60 deg.) to 180 deg.

2. The Angle N S A, 31 deg. 30 min. the Angle observed to A, at the second *Station*; and
3. The Side comprehended between them, *viz.* the *Stationary* distance N S, 220 Perches.

To find N A.

Having the Angle A S N 31 deg. 30 min. and the Angle A N S 120 deg. you have also the Angle N A S 28 deg. 30 min. given, it being the Complement of the other two, to 180 deg. Then,

By the I. *Case* of Oblique-angled Triangles.

As s N A S	:	N S	: :	N S A	:	A N.
$23^d 30^m$	:	220 P.	: :	$31^d 30^m$	:	240.9 P.

Example 2. *For the distance from your second Station* S, *to the first Ship at* A, *making the Triangle* N A S.

By the foregoing I. *Case*.

As s N A S	:	N S	: :	s A N S	:	A S
$23^d 30^m$	:	220 P.	: :	60^d	:	399.6 P.

Example 3. *For the distance from* N *to* B.

In the Triangle N B S, there is given,

1. The Angle B N S 105 deg. 30 min. the Complement of the Angle made to B at the first *Station* at N, 74 deg. 30 min.
2. The Angle B S N 38 deg. 40 min. the Angle observed at your second Station to B.
3. The Stationary distance N S 220 P.

To find N B.

Having the Angle B N S 105 deg. 30 min. and the Angle N S B 38 deg. 40 min. you have also the Angle N B S 35 deg. 30 min.

By the I. *Case* of Oblique-angled Triangles.

As s N B S	:	N S	: :	s B S N	:	N B
$35^d 30^m$	:	220	: :	$38^d 40^m$	:	236.7

Example 4. *For the distance* A B.

In the Triangle A N B there is given,

1. The side A N, 241.9.
2. The side B N 236.7.
3. The Angle A N B 14 deg. 30 min. it being the difference between the two Angles made at the two Observations from N to A and B.

Then by the IV *Case* of Oblique-angled Triangles.

As the summ of the sides A N and B N, 478.6.
Is to their *Difference* 5.2.
So is the *Tangent* of half the Summ of the Angles N A B and N B A 82 deg. 45 min.
To the *Tangent* of 4 deg. 53 min.
Which added to 82 deg. 45 min. makes 87 deg. 38 min. for the Angle A B N, and subtracted from 82 deg. 45 min. leaves 757 deg. 52 min. for the Angle B A N.

Then by the I. *Case*.

As s A B N	:	A N	: :	s A N B	:	A B.
$57^d 51^m$	:	241.9 P.	: :	$4^d 30^m$	:	61 P.
s 87.38.	:		: :		:	

And in this manner may *Maps* or *Plots* of all eminent *Places* in *Cities*, *Towns*, &c. be taken. But having been so large in the explaining of this, I shall be the more brief in those which follow.

SECT.

SECT. IV. *How to take the* Distances *of the most Remarkable* Places *in a Town or City.*

LEt A, B, C, D, E, F, G, H, K, L, M, be some eminent Places in a City, such as are nominated in the Table following; of which make choice of two, from either of which all the other may be seen, as L, *St. Giles's*, and M, *St. Hellen's*: Then upon *St. Giles's*, at L, set up your *Theodolite*, laying the *Index* upon the North and South Diametre thereof; and then turn the *Theodolite* about, till through the Sights you see *St. Hellen's* at M, and there fix it. *Fig.* XIII.

Then move the *Index*, till through the Sights you see the *North Gate*, the *Index* cutting 37 deg. 30 min. Then direct it to the *School-house*, the *Index* cutting 77 deg. and so to all the Remarkable Places about the Town, noting down what Degrees the *Index* cut at every Place, which suppose to be such as are exhibited in the second Column of the following Table, under *Station* I. *St. Giles's*.

Then removing from *St. Giles's* to *St. Hellen's*, there set up your *Theodolite*, laying the *Index* upon the North and South Diametre thereof, (as before,) and turn the *Theodolite* about, till through the Sights you see *St. Giles's*, and there fix it.

Then turning the *Index* about, direct your Sights to the *North Gate*, the *Index* cutting 16 deg. 30 min. which note down; then to the *School-house*, the *Index* cutting 36 deg. 45 min. and so to all the remarkable Places, as before; so shall you find the Degrees cut by the *Index* at the several Directions, to be such as are set down in the last Column of this Table, under *Station* II. *Hellen's*.

The Table of Observations.

The Names of the Places you observe.	Station I. St. *Giles's*. deg.	min.	Station II. St. *Hellen's*. deg.	min.
A *North Gate*	37	30	16	30
B *School-house*	77	00	36	45
C *Christ-Church*	115	20	27	45
D *Prison-house*	133	45	60	00
E *St. Bennet's*	168	00	140	15
F *South Gate*	187	30	197	30
G *The Hospital*	210	45	269	00
H *The Town-Hall*	216	30	248	45
K *Old Tower*	317	20	342	30

Having thus finished your *Table of Observations*, the next thing that you are to doe, is to find the Distance between L, *St. Giles's*, and M, *St. Hellen's*; which to doe, (if you connot conveniently measure it within the Town,) you may go out thereof, into some near adjoyning Field, or other open Place, where you may conveniently see both the Places; as, suppose, in a Field at O and R; where,

1. Set up your *Theodolite* at O, the *Index* lying on the North and South Diametre thereof, and there turn the *Theodolite* about, till through the Sights you see *St. Giles's* at L; and then fix the Instrument.

2. The Instrument thus fixed, direct the Sights to any Mark set up at a distance, as at R, the *Index* there cutting 106 deg. and then to *St. Hellen's*, the *Index* cutting 40 deg.

3. Measure the Distance between O and R, which let be 470 Geometrical Paces, (of 5 Foot to a Pace,) or 2350 Foot.

4. Set up your *Theodolite* at R, the *Index* lying upon the Diametre, as before, turning it about till through the Sights you see a Mark set up at your former Station at O, and there fix it: Then move the *Index*, till through the Sights you see *St. Giles's* at L, the *Index* cutting 36 deg. Then move it forwarder, till you see *St. Hellen's* at H, the *Index* cutting 65 deg. 30 min. And by these two Observations the Distance between *St. Giles's* and *St. Hellen's* may be obtained by the Directions in the foregoing *Section*. For,

In the Triangle L O R, you have given, (1.) The Distance O R, 2350 Foot. (2.) The Angle L O R, 106 deg. (3.) The Angle L R O, 36 deg. And having the Angles L O R, 106 deg. and L R O, 36 deg. the Summ of them is 142 deg. whose Complement to 180 deg. is 38 deg. for the Angle O L R, to find L O: Then by the *First Case* of *Oblique angled Triangles*,

As s O L R : O R : : s L R O : L O.
38 d. 2350 : : 36 d. : 2244.

And by the forementioned I. *Case* may L R be found. For,

As s O L R : O R : : s L O R : L R.
38 d. : 2350 : : 106. or 74 d. : 3669.

And again, In the Triangle O M R, there is given, (1.) O R, 2350. (2.) O R M, 65 deg. 30 min. (3.) The Angle M O R, 66 deg. and also the Angle O M R, 48 deg. 30 min. to find M R; which by the forementioned *Case* I. may be thus found.

As s O M R : O R : : s M O R : M R.
48 d. 30 m. : 2350 : : 66 d. : 2866.

Then for the Distance L M, in the Triangle L R M, there is given, (1.) The Side L R, 3669. (2.) The Side M R, 2866. (3.) The Angle L R M, 29 d. 30 m. comprehended between L R and M R, to find the Side L M. By the IV. *Case* of *Oblique-angled Triangles*,

As the Summ of the Side L R and M R, 6535,
Is to the Difference of the same Sides, 803;
So is the Tangent of half the Summ of the two Angles R L M, and R M L, 75 d. 15 m.
To the Tangent of 25 deg.

Which 25 deg. added to the half Summ, 75 deg. 15 min. makes 100 deg. 15 min. for the Angle L M R; and being subtracted therefrom, leaves 50 deg. 15 min. for the Angle M L R.

Then by the I. *Case*,

As s M L R : M R : : s L R M : L M.
$50^d\ 15^m$: 2866 : : $29^d\ 30^m$: 1832.

Thus having found the Distance between *St. Giles*'s at L, and *St. Hellen*'s at M, to be 470 Paces, or (rather) 2350 Foot, you may lay down all the other Places according to their true Distances and Situations one from another, by the Directions of the second Section before-going, and as you see done in *Figure* XIII.

The End of the First Part.

Fig. X.

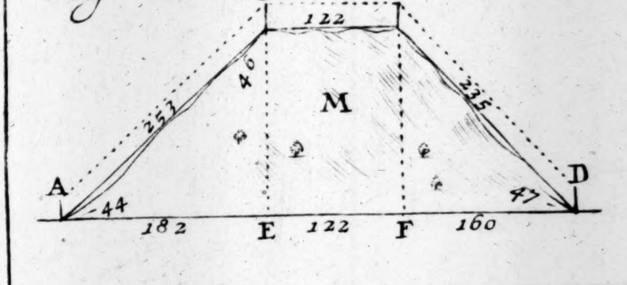


Fig. XI.

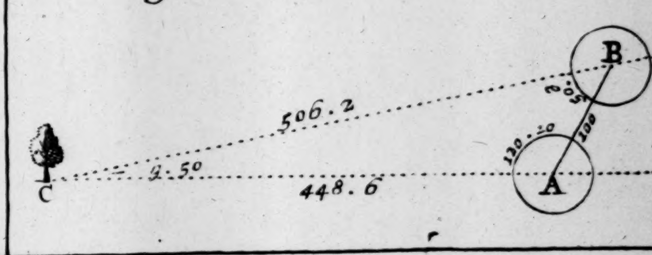


Fig. XII.

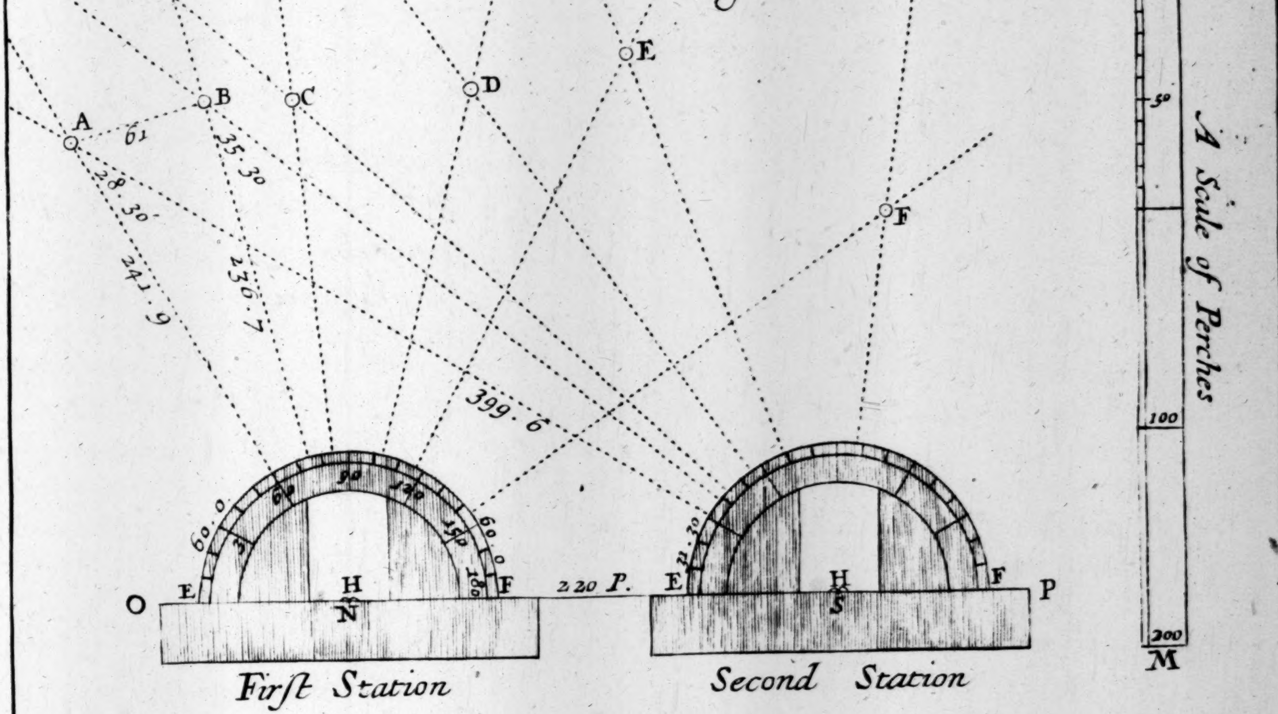
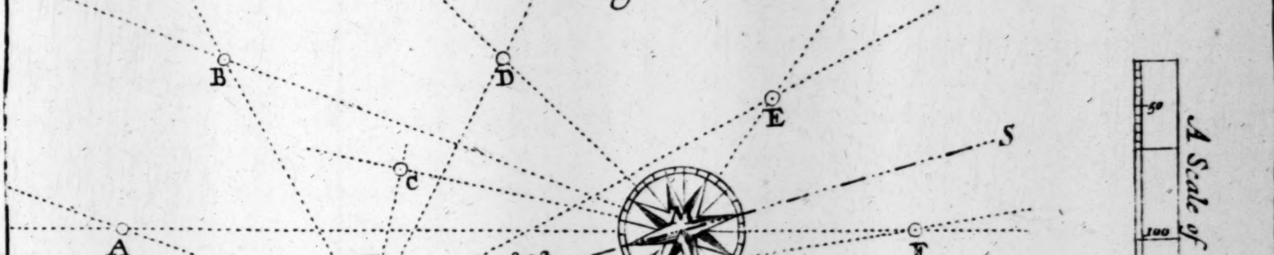


Fig. XIII.



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THE DOCTRINE OF RIGHT-LINED TRIANGLES, Applied to PRACTICE IN PLANOMETRIA, OR Surveying of Land.

PART II.

THE *Instrument* which I ſhall principally make uſe of in this Tractate of *Surveying* of *Land*, ſhall be the *Theodolite* before deſcribed, *Chap.* I. *Sect.* V. of *Longimetria*: And the *Chain*, ſuch as is deſcribed in the Fourth *Paragraph* of the VI *Section* of the ſaid *Chap.* I. And the *Scales* and *Protractor* the ſame as are alſo there deſcribed in the II. and III. *Sections*. The Uſes of all which are in the forementioned I. *Chapter* ſufficiently taught: Wherefore I ſhall ſay nothing more of them here, but enter the *Field* to *Survey*.

CHAP. I.

How to take the Plot *of a* Field *or ſmall* Incloſure *at one Station, taken in any Place within the ſame, from whence all the* Angles *may be ſeen.*

WHen you have entred your *Field*, and made choice of a convenient Place to fix your *Inſtrument*, cauſe *Marks* (or *Whites*) to be ſet, or held up, at every *Angle* of the *Field*; to which *Marks* direct the *Sights*, and note what Degrees the *Index* cuts, &c. *Fig.* I.

Let A B C D E F be a ſmall Incloſure to be Meaſured, having made choice of a Place about the middle thereof, as at ⊙, from whence you may ſee all your *Marks* at A B C D E and F; fix there your *Theodolite*, the *Needle* hanging directly over the *Meridian-line* in the *Card*. Then,

Firſt, Direct your *Sights* to A, the *Index* cutting 36 deg. 45 min. which note down in your *Field Book* in the Second Column thereof: and Meaſure the Diſtance from

 ⊙ to

⊙ to A, containing 8 *Chains* 10 *Links:* which set down in the Third Column of your *Field Book.*

Secondly, Direct the *Sights* to B, the *Index* cutting 99 deg. 15 min. and the Distance from ⊙ to B 8 *Chains* 75 *Links:* both which set down in your *Field Book* as before.

Doe the like for the rest of the *Angles* from ⊙ to C, D, E and F: and set them down as you observe them, with their Distances measured as you see done in the following *Table.*

	D.	M.	Cha.	Lin.
A	36	45	8	10
B	99	15	8	75
C	163	15	10	65
D	212	00	8	53
E	287	15	8	15
F	342	00	9	55

Having thus finished your Work in the *Field,* the next thing to be done is to *Protract* the same; that is, to lay down a *Plot* thereof upon Paper or Parchment: Which shall be the Work of the following *Chapter.*

CHAP. II.

How to Protract *any* Observations *taken according to the* Directions *of the last* Chapter.

DRaw a Line upon Paper or Parchment, as N S, representing the *Meridian Line.* Then in some part of that Line, as at ⊙, make a Point, representing your Place of Standing in the Field: Upon this Point place the Centre of your *Protractor,* so that the *Diametre* thereof, E F, may lie directly upon the Line N S of this *Figure* I.

Then laying your *Field Book* before you, and seeing that at the first Observation to A, the *Index* cut 36 deg. 45 min. therefore against those Degrees make a prick by the Side of your *Protractor.*

2. At the Second Observation to B, the *Index* cut 99 deg. 15 min. against which make a prick as before.

3. At the Third Observation to C, the *Index* cut 99 deg. 15 min. against which also make a prick.

4. The Degrees cut by the *Index* at the Fourth Observation to D, were 212 Degrees; (Which being above 180 deg. you must turn the *Semicircle* of the *Protractor* downwards; yet so that the Centre of the *Protractor* may lie just upon the Station-Point ⊙, and E F upon the Line N S, as before it did,) against which Degrees make a prick upon your Paper.

5. The Degrees cut at the Fifth Observation to E, were 287 deg. 15 min. against them also make a prick. And,

6. The Degrees cut at the last Observation to F, were 342 deg. against them also make a mark.

Having thus made Marks upon your Paper against the several Degrees that were cut by the *Index:* Take away the *Protractor,* and laying a *Ruler* to the Station-Point ⊙, draw obscure Lines from thence through those Points: Then the Line at your first Observation from ⊙ to A being measured, 8 Chains 10 Links, take 8 Chains 10 Links from your Scale, and set them upon the first obscure Line from ⊙ to A; which shall give you the angular Point A in the *Field.*

	Cha.	Lin.		
	8	75		B
	10	65		C
In like manner, ſet	8	53	upon the obſcure Lines, from ⊙ to	D
	8	15		E
	9	55		F,

So ſhall the Points A, B, C, D, E, F, upon your Paper, repreſent the ſeveral Angles in the Field. And,

Laſtly, Lines drawn from one Point to another, as the Lines A B, B C, C D, D E, E F, and F A, ſhall incloſe the true Figure of the Field.

CHAP. III.

How to take the true Plot *of a* Field *at Two Stations, taken in any Two Parts thereof, from whence the Angles may be ſeen.*

THis manner of Working is chiefly to be uſed in ſuch Fields whoſe Irregularity will not admit of any one Place from whence all the Angles may be ſeen. The manner of Work in this, as alſo the Protraction, will be the ſame with that in the two preceding Chapters hereof; only in this the Inſtrument muſt be twice placed, (and ſometimes thrice,) whereas in the other it was but once.

Suppoſe therefore, that A B C D E F G H I K L and M were ſuch an irregular Field: You muſt firſt find out two Places, as ⊙ and Q, for two Stations, ſo that at both of them all the Angles may be ſeen, though not at once from any one of them, but at both; for thoſe Angles that cannot be ſeen from ⊙, may be ſeen from Q; and thoſe that cannot be ſeen from Q, may be ſeen from ⊙. *Fig.* II.

Your two Stations, ⊙ and Q, being choſen, ſet up your *Theodolite* at ⊙, and turn it about till the Needle hang over the Meridian Line; and there fixing it, direct the Sights to A, the *Index* cutting 19 deg. 10 min. And the Line ⊙ A meaſured 7 Chains 46 Links, place the 19 deg. 10 min. in the ſecond, and the 7 Cha. 46 Lin. in the third Column of your *Field-Book.*

Then direct the Sights to B, the Index cutting 53 deg. 30 min. and the Line ⊙ B meaſured 7 Ch. 18 Lin. which note down as before.

In this manner proceed with the reſt of your Lines and Angles, namely, ſo many of them as you can conveniently ſee from your firſt Station at ⊙, as thoſe at A, B, C, D, K, L, and M.

This done, direct your Sights to your ſecond Station at Q, the Index cutting 161 deg. 45 min. (or rather 18 deg. 15 m. below 180 deg.) which note down in your *Field-Book* by it ſelf; and alſo the Diſtance between the two Stations ⊙ and Q, 8 Cha. 89 Lin.

Having thus finiſhed one part of the Field, remove your Inſtrument to the other Station at Q, and laying the *Index* upon 18 deg. 15 min. thereof, (which is the Inclination or Difference of the Meridians of the two Stations,) turn it about, till through the Sights you ſee your firſt Station at ⊙, and there fix it; then will the Needle hang over the Meridian Line, and the Inſtrument truly ſituate.

Then direct the Sights to E, the *Index* cutting 52 deg. 15 min. and the Line Q E meaſured 5 Chains 10 Links, which muſt be noted in your Field-Book, in all reſpects as before.

In this manner make Obſervation of the Degrees cut at E, F, G, H, and I, and of the Lengths of the Lines; all which being collected into your Field-Book, will ſtand as you ſee in the following Table.

The

The Field-Book.

	D.	M.	Ch.	Li.	
A	19	10	7	46	At the first Station ⊙.
B	53	13	7	18	
C	95	15	7	21	
D	132	00	6	33	
E	166	30	5	57	
K	251	30	7	83	
L	282	00	9	95	
M	304	30	8	05	

The Stationary Distance is 8 Chains, 89 Links; and the Angle ⊙ Q N, 18 d. 15 m. the Inclination of the two Meridians.

	D.	M.	Ch.	Li.	
E	52	15	5	10	At the second Station Q.
F	99	30	7	64	
G	148	30	6	40	
H	232	30	5	33	
I	275	00	6	95	
K	321	20	7	61	

CHAP. IV.

How to Protract the Observations taken according to the Work of the last Chapter.

Fig. II.

UPon your Paper draw a Meridian Line, N ⊙ S, the Point ⊙ representing your first Station. Upon this Point ⊙ place the Centre of the *Protractor*, laying the Line E F thereof directly upon the Meridian Line hereof, N S: Then laying the Field-Book before you, observe the Degrees there noted, and the Lines measured, namely,

(1.) At A, 19 deg. 10 min. and the Line ⊙ A, 7 Chains 46 Links.
(2.) At B, 53 deg. 30 min. and the Line ⊙ B, 7 Chains 18 Links.
(3.) At C, 95 deg. 15 min. and the Line ⊙ C, 7 Chains 21 Links.

and so of the rest, against which Degrees and Minutes make Marks by the edge of your *Protractor*, and draw Lines from ⊙ through these Marks, as ⊙ A, ⊙ B, ⊙ C, ⊙ D, ⊙ E, ⊙ K, ⊙ L, ⊙ M; and upon these Lines set off their several Lengths from ⊙, as you find them in your Field-Book.

Having thus Protracted the Observations at your First Station, (before you move your *Protractor*,) make a Mark against 18 deg. 15 min. and draw th Line ⊙ Q, setting off upon it 8 Chains 89 Links, the Length or Distance between the two Stations ⊙ and Q.

Then upon Q place the Centre of the *Protractor*, as before, moving it up and down, till the Line ⊙ Q lies just under 18 deg. 15 min. of the *Protractor*; and holding it there, lay your Field-Book before you, and prick down by the Edge thereof the several Degrees and Minutes, as by your Instrument you observed them, together with the Lengths of the Lines, as they were measured, drawing Lines through those Points also, as the Lines Q E, Q F, Q G, Q H, Q I, Q K.

Lastly, Draw the Lines A B, B C, C D, D E, E F, *&c.* So shall you have upon your Paper the exact Plots of your Field; in which (if there be no Error in the Work) the Line M A being drawn, will close exactly with the Point B A, in the Point A.

CHAP.

CHAP. V.

How to take the Plot *of a* Field *at Two Stations, taken in any Two Places thereof, from either of which all the Angles in the Field may be seen, and by measuring only the Stationary Distance.*

THe Work of this Chapter, both for the *Observation* and *Protraction*, differeth nothing from that in the Second, Third, Fourth, and Fifth Sections of the Second Chapter of *Longimetria* beforegoing; and therefore in it I will be very brief. *Fig.* III.

Let the Field to be Plotted be A B C D E F G H: Having made choice of two Places for your two Stations, as ⊙ and Q, place your *Instrument* at ⊙, and turn it about till the *Needle* hang over the *Meridian Line* in the *Card*, and there fix it. Then,

				Deg.	Min.	
First,	Direct the Sights to	A	The *Index* cutting	21	30	At the First Station at ⊙.
Secondly,		B		69	15	
Thirdly,		C		124	45	
Fourthly,		D		168	10	
Fifthly,		E		202	30	
Sixthly,		F		237	30	
Seventhly,		G		307	00	
Eighthly,		H		328	30	

This done, measure the Distance between your two Stations ⊙ and Q, which is 7 Chains, and remove your *Theodolite* to Q, turning it about till the *Needle* hang directly over the *Meridian Line* of the *Card*, as before, and there fix it. Then,

				Deg.	Min.	
First,	Direct the Sights to	A	The *Index* cutting	11	00	At the second Station at Q.
Secondly,		B		35	30	
Thirdly,		C		79	45	
Fourthly,		D		153	15	
Fifthly,		E		224	30	
Sixthly,		F		279	30	
Seventhly,		G		329	00	
Eighthly,		H		347	30	

Thus having made your Observations to all the Angles round about the Field, at both Stations, and set them down in your Field-Book, and also the Distance between your two Stations, as you see here done, you may proceed to Protract your Work, as is directed in the following Chapter.

CHAP. VI.

How to Protract *the* Observations *taken by the last* Chapter.

DRaw a Right-Line, as NS, representing the *Meridian*: upon which Line assume any Point at pleasure, as ⊙ for your first Station; unto which Point apply the Centre of your *Protractor*, with the Diametre EF thereof, upon the *Meridian Line* NS before drawn. Then look into your *Field Book* for the Degrees and Minutes observed at the first Station at ⊙, and against every of them make Marks by *Fig.* III.

by the Edge of your *Protractor* upon your Paper: And when you have marked them all, draw obscure Lines from the Station ⊙, through every of them; as the Lines ⊙ A, ⊙ B, ⊙ C, *&c.*

This done, take 7 *Chains*, (your Stationary Distance,) and set it upon the *Meridian Line* NS, from ⊙ to Q.

Upon the Point Q (your second Station) apply the Centre of your *Protractor*, with the Diametre EF thereof, upon the Line NS, as before: Then from your *Field Book* take all the Observations you made at Q, and against them make Marks by the Edge of the *Protractor*, upon your Paper; and through those Points, from the Point Q, draw the Right-Lines QA, QB, QC, *&c.*

The Line	Q A	Intersecting or Crossing the Line	⊙ A	in the Point	A
	Q B		⊙ B		B
	Q C		⊙ C		C
	Q D		⊙ D		D
	Q E		⊙ E		E
	Q F		⊙ F		F
	Q G		⊙ G		G
	Q H		⊙ H		H

Lastly, If you draw the Right Lines, from Point to Point, of these Intersections; as the Lines AB, BC, CD, DE, EF, FG, GH, and HA, they will give you the true *Plot* or *Figure* of the *Field* so taken: as in the foregoing *Chapter*.

CHAP. VII.

How to take the Plot *of a* Park, Common, *or* Large Champion Plain, *by going round about the same, and making Observation at every* Angle *thereof.*

Fig. IV. First place your *Instrument* at the *Angle* A, and lay the *Index* on the Diametre thereof, turning the whole *Instrument* about, till through the Sights you see the second *Angle* at B, and there fix it: Then turn the *Index* about backwards till you see the *Angle* at G, the *Index* cutting 97 deg. which is the quantity of the *Angle* GAB: and measure the Line AB, containing 12 *Chains* 5 *Links*; which set down in your *Field Book*, as formerly.

2. Remove the *Instrument* to B, the *Index* lying upon the Diametre, and turn the whole *Instrument* about, till by the Sights you see the third *Angle* at C, and there fasten it; then turn the *Index* backwards, till through the Sights you see the *Angle* at A, the Degrees cut by the *Index* being 120 deg. 30 min. and the Line BC 4 *Chains* 45 *Links*; which note down.

3. Remove the *Theodolite* to C, the *Index* lying upon the Diametre, turning the *Instrument* about, till you see the fourth *Angle* at D, and there fix it; then turn the *Index* backwards till you see the *Angle* at B, the *Index* cutting 132 deg. 30 min. and the Line CD 8 *Chains* 85 *Links*.

4. Bring the *Instrument* to D, turning it about till you see the fifth *Angle* at E, and there fix it; then turn the *Index* backwards, till through the Sights you see the *Angle* at C, the *Index* cutting 125 deg. and the Line DE 13 *Chains* 4 *Links*.

5. Remove the *Theodolite* to E, turning it about till you see the sixth *Angle* at F, and there fix it; turning the *Index* backwards to D, it cutting 121 deg. 30 min. and the Line EF 7 *Chains* 70 *Links*.

6. Remove the *Theodolite* to F, turning it about till you see the seventh *Angle* at G, and there fix it; then turn the *Index* backwards, till through the Sights you see the *Angle* at E, the *Index* cutting 80 deg. and the length of the Line FG 5 *Chains* 67 *Links*.

7. *Lastly*, Place the *Instrument* at G, and the *Index* lying upon the Diametre, turn the whole *Theodolite* about, till through the Sights you see the *Angle* at A, where you began; and there fixing it, direct the Sights backwards to F, the *Index* cutting 224 deg. and the Line GA 7 *Chains* 87 *Links*.

Having

Having thus made *Observation* at every *Angle* of the *Field*, and measured the Length of every Line, and entered them into a *Field Book*, you will find them to stand as in this *Table*.

	D.	M.	Cha.	Lin.
A	97	00	12	5
B	120	30	4	45
C	132	00	8	85
D	125	00	13	4
E	121	30	7	70
F	80	00	5	67
G	224	00	7	87
	900	00		

CHAP. VIII.

How to Protract *the* Observation *taken in the last* Chapter.

1. DRaw a Line, as A G; then apply the Centre of your *Protractor* to the Point A, and (because the Degrees cut at your first *Observation* were 97 deg.) turn the *Protractor* about, till the Line A G lie directly under 97 deg. and then at the beginning of the Degrees of the *Protractor* (marked with the Letter E) make a Mark, and through it draw the Line A B; setting 12 *Chains* 5 *Links* upon it from A to B. *Fig.* IV.

2. Apply the Centre of the *Protractor* to the Point B, and turn it about, till 120 deg. 30 min. (the Degrees cut by the *Index* at B) do lie just over the Line A B: and at the beginning of the Degrees make a Point upon your Paper; through which draw the Line B C, containing 4 *Chains* 45 *Links*.

In this manner must you deal with all the rest of the *Angles*: And when you come to *Protract* the *Angle* at F, and have drawn the Line F G, you shall find it to cut the Line A G, first drawn, in the Point G, leaving the Line A G to contain 7 *Chains* 85 *Links*, and the Line F G, 5 *Chains* 67 *Links*.

In the performance hereof, Practice is better than many Words, and the Sight of the *Figure* more than Information; in which you may see the *Protractor* lie in its true Position at every *Angle*.

CHAP. IX.

How to Discover whether the Angles *made at your several* Stations *be truly taken or not.*

THis way of Surveying, (which is inferior to none, although not altogether so expeditious as some ways which follow,) hath a preheminence above the rest; for by help of your *Field Book* you may (before you go out of the *Field*) know whether your *Plot* will close at the end of your *Protraction*, before you begin: And for to effect it, this is the

RULE.

Multiply 180 *deg. by a Number less by two than the Number of the Sides or Angles in your* Plot, *the Product of that Multiplication shall be equal to the Summ of all the Angles observed.*

Example. In the *Plot* of the *Field* last taken, [*Fig.* IV.] the Number of the *Sides* or *Angles* thereof are *Seven*, two less is *Five*: wherefore Multiply 180 by 5, and the Product will be 900. Then add all *Angles* of your several Observations together,

as

as they stand in your *Field Book*, and they make 900 also; which demonstrates the *Angles* to be truly taken: for if they had differed, there had been some error committed in your Observations.

Note, That the quantities of all *Angles*, are to be reckoned in the inside of the *Plot*, and not without, as in the foregoing *Plot*, the *Angle* at G being 224 deg. These are counted within the *Field*, but the outward *Angle* thereof is but 136 deg. by which *Angle* it must be Protracted, as in the *Figure* is evidently seen.

CHAP. X.

A more Compendious way of taking the Plot *of any* Wood, Park, *or other large* Champion Plain, *by the* Theodolite; *by going about the same, and making Observation at every* Angle *of the same.*

Fig. V. LET ABCDEFGHK be a large *Common Field*, or the like, to be Plotted.

In this way of Surveying, you must always observe this Method; *viz.* (1.) At every Station, to set the *Instrument* so that the *Needle* may hang directly over the *Meridian Line* in the *Card*. And (2.) to keep one end of the *Index* next your Eye, and not sometimes one and sometimes another, for that will cause confusion in your Work. Then (3.) always count the Degrees which are cut by that end of the *Index* which is farthest from you. Observing these *Cautions*, I will proceed to the *Practice*; in which, as also in the *Protraction*, I will be very brief.

Place the *Theodolite*, the *Needle*, being over the *Meridian Line* of the *Card*, at	and direct the *Sights* to	The *Index* cutting D.	M.	And the Line	containing Ch.	Lin.
A	B	191	00	A B	10	75
B	C	279	00	B C	6	83
C	D	216	30	C D	7	82
D	E	325	00	D E	6	96
E	F	12	30	E F	9	71
F	G	324	30	F G	7	54
G	H	98	30	G H	7	54
H	K	71	00	H K	7	74
K	A	161	30	K A	8	22

Having gone round about the *Field* in this manner, and collected the Degrees cut by the *Index*, and the Lines measured by the Chain into a *Field Book*, they will stand as above: By help whereof you may *Protract* and draw a *Plot* thereof, as shall be directed in the following *Chapter*, very much differing from all the former ways of Protraction.

CHAP. XI.

How to Protract *the* Observations *taken according to the Directions of the last* Chapter.

Fig. V. UPon a Sheet of Paper, or Skin of Velom, as L M N O; draw several Lines parallel one to another, as in the *Figure*, but let the Distance of those Parallels be less than the Breadth of the Square part of the *Protractor*. These Parallel Lines are called *Meridians*: and upon (or parallel to) one of these, must the *Meridian Line* of your *Protractor*, noted with E F, always be laid.

Your Paper or Velom thus prepared, assign a Point upon any *Meridian* (as A;) upon this Point A place the *Centre* of the *Protractor*, and the *Meridian Line* thereof,

E F, upon the *Meridian* of your Paper: Then by your *Field-Book* you find that the Degrees cut by the *Index* at A, were 191 deg. which being more than 180, lay the Semicircle of the *Protractor* downwards, and against 191 deg. make a Mark with your *Protracting-Pin*; then from A, through this Point, draw the Line A B, to contain 10 Chains 75 Links.

2. Apply the Centre of the *Protractor* to the Point B, with the *Meridian Line* E F thereof, parallel to one of the pricked *Meridians* upon the Paper: And seeing the Degrees cut at B are more than 180, *viz.* 279, lay the *Protractor* downwards, (as before,) and make a Mark against 279 deg. through which draw the Line B C, containing 6 Chains 83 Links.

3. Apply the *Protractor* to C, and the *Meridian* of it parallel to the *Meridians* on the Paper, and the Degrees cut at C being more than 180, *viz.* 216 deg. 30 min. lay the *Protractor* downwards, and make a Mark against 216; through which, from C, draw the Line CD, containing 7 Chains 82 Links.

4. Lay the Centre of the *Protractor* upon D, the Semicircle downwards, and against 325 deg. (which were cut by the *Index* at D,) make a Mark, through which draw a Line from D to E, to contain 6 Chains 96 Links.

5. Apply the Centre of the *Protractor* to the Point E, and the *Meridian Line* thereof upon (or parallel to) one of the *Meridians* upon the Paper: Now (because the Degrees cut by the *Index* at this Observation made at E, were less than 180, *viz.* but 12 deg. 30 min.) therefore lay the Semicircle of the *Protractor* upwards, and make a mark or prick against 12 deg. 30 min. through which, from the Point E, draw the Line E F, to contain 9 Chains 71 Links.

In this manner must you *Protract* all the other *Angles* at F, G, H, and K; and more, if more had been: Remembring always, that if the Degrees to be Protracted be less than 180, the Semicircle of the *Protractor* must be placed upwards; but if above 180 deg. downwards.

CHAP. XII.

How to take the Plot *of a* Lordship, *or* Mannor, *consisting of divers Severals, as* Pasture, Arable *and* Wood-Land.

I Need not use many Words to illustrate what I intend to teach in this *Chapter*, having already several ways declared the manner how this Work, or the like, may be performed: Yet I will here shew one other way, somewhat (though not much) differing from the last way in *Chapter* X: and in the Explanation thereof I shall be very brief, giving you only the Sight of a *Field-Book*, in which the Observations were entred that were taken in the several *Fields*: the *Sight* whereof, compared with the *Figure*, (observing the Directions in the two foregoing *Chapters*,) will give more Light than a large *Chapter* of Information or Precepts.

The Form and Order of the Field-Book.

		C. L.		
		⊙ 1		
	C. L.	0d 0′	C. L.	
	0 10	At ⊙	0 10	
		1 15	0 16	and a Gate
a Gate	0 52	2 20		
	0 15	2 45		
		2 83	0 45	and a Hedge
a Hedge	0 50	4 0		
		4 77	0 0	
		5 00	0 60	
	0 30	5 81		
		6 80	0 60	
	0 45	7 0		
	0 0	7 20		
		7 60	0 20	
		8 25		
	0 30	⊙ 2	0 40	
		151 0	<	
a Hedge and Stile	0 25	At	9 52	a Gate
		1 38		
	0 10	1 58		
		1 94		
	0 25	⊙ 3	0 16	
	>	161 0		
		At		
	0 10	1 10		
Lanes end	0 30	2 43		
		2 60	0 42	Lanes End(
		2 85		
	0 50	⊙ 4		
		100d 36′	<	
		At		
		0 20	0 60	Lanes End
	0 60	1 0		
		1 45	0 15	
	0 35	1 95		
		2 30	0 65	
		2 70	0 20	
		3 55	0 45	Lanes End
		3 80		
		⊙ 5		
		79d 0′	<	
		At		
Lanes Corner	0 15	0 20	0 25	
		0 50		Corner of the Lane
		1 40		
	>	⊙ 6		
	0 20	129d 0′	0 25	
	0 20	0 73	0 25	
	0 20	⊙ 7	0 25	
		118d 0′	<	
		At		
	0 40	1 10		
		1 40	0 0	
		2 30	0 60	
	0 20	2 40		
		2 60	0 45	

		C. L.		
		⊙ 8		
	>	139½d		
		At		
		0 70	0 15	and 1 C. 0 L. more.
	0 15	1 35		
	0 20	2 40	0 30	
		2 80		The Station's

end: But set forwards 0 C. 60 L. to against a Hedge, and set off to the Right 30 L. for the Hedge Corner at *a*.

		⊙ 9		
		80d 0′	<	
		At		
	0 35	0 30		I cross a
		1 10	0 60	Hedge.
	0 97	1 88		
		2 15	0 20	
	2 30	3 05		
		⊙ 10		
		131d 6	<	
		At		
		0 32	0 73	
		1 05	1 25	
	1 95	1 25		
		1 70	0 55	
	1 08	2 40		
		2 82	0 75	
		4 00		The Station's

end, and the Wood enclosed.

Having thus far proceeded, and inclosed the Wood in your Protraction, according to the Notes in your *Field-Book*, from the Points set off in your *Field-Book* to the left Hand in your 9th and 10th Stations, which will be the Points *a*, *b*, *c*, *d*, and *e*.— If you now draw the Lines *a b*, *b c*, *c d*, *d e*, *e f* and *f g*, you shall have inclosed *West Field* also.

Then going to your *Instrument*, standing all this while at your 10th Station, direct it to your 11th Station, and enter your Notes in your *Field-Book* as followeth.

	>	⊙ 10 128½d		Making an *Angle* with ⊙ 9 of 128½d
		At		
		3 35	1 90	
	0 00	3 70		
		4 50	1 22	
	0 45	5 20		
		⊙ 11		
		100d 6	<	
		At		
	0 20	0 00		
	0 65	1 35		
		1 75		I cross a Hedge.
		4 60		

I am come now to my First Station, where I first began.

Observe

Observe well the Field-Book *foregoing, and compare it with* Figure VI.

YOur *Instrument* being placed at Station 1, [thus marked in the *Figure* ⊙ 1,] and your Sights directed to ⊙ 2, your Visual Line was ⊙ 1, ⊙ 2.— In the measuring of which Line I find, by my *Field-Book*, that at ⊙ 1 I was distant from the Hedge corners on either side 10 Links of a Chain: wherefore upon a Sheet of Paper I draw a Right Line, as ⊙ 1, ⊙ 2, and on either side thereof I set 10 Links from ⊙ 1 to *n* on the Right-hand, and from ⊙ 1 to *s* on the Left-hand. — Then I find by my *Field-Book*, that at the end of 1 Chain and 15 Links, my Visual Line is distant from the bow of the Hedge on the Right-hand 16 Links, which I set from my Visual Line to *o*, and draw *n o*. Also, at the end of 2 Chains 45 Links, I find that I am distant from a bow in the Hedge and a Gate there 52 Links: wherefore I set 52 Links from my Visual Line to *t*, and draw the Line *s t*. And in this manner I proceed (as my *Field-Book* directs me) till I have gone quite round the several parcels to be Surveyed, (which are here Six:) and proceeding in this manner, you shall have the true *Plot* of all your Severals, as in the *Figure*; which you may cast up and order according to the directions following.

And now having finished your Field-work of these Four other Closes, and by your Protraction found the Points *b, i, k, l, m, n, o, p*, and *q*, if you draw the Lines *c b, b i, i k*, and *k d*, you shall have inclosed the *Upper Fall.*—— And if you draw the Lines *k p, p r*, and *r s*, you shall inclose *Brill Mead.* — Also, if you draw the Lines *i q, q n, n o*, and *o p*, you will inclose the *Lower Fall.* —— *Lastly*, If you draw the Lines *b l, l m*, and *m p*, you will inclose the *East Picle.*

CHAP. XIII.

The Construction, Description, and Use of a Decimal Table, *Shewing the Difference of* Longitude *and* Latitude *of any* Line *at every Degree of Intersection with the* Meridian, *for the ready finding the* Easting *and* Westing, Northing *and* Southing *of any Measured* Line, *having its* Bearings, *and also the* Perpendicular Altitude *and* Horizontal Line *of any* Hill *or* Mountain.

The Decimal Table.

D	10	20	30	40	50	60	70	80	90	100
01	0017	0035	0052	0070	0087	0104	0121	0139	0156	0174
02	0035	0070	0105	0140	0174	0210	0244	0280	0314	0349
03	0052	0105	0157	0209	0262	0310	0364	0416	0468	0523
04	0070	0140	0209	0279	0349	0420	0488	0558	0628	.0698
05	0087	0174	0261	0349	0436	0523	0610	0697	0784	0872
06	0105	0209	0314	0418	0523	0628	0732	0837	0941	1045
07	0122	0244	0366	0487	0609	0731	0853	0975	1097	1219
08	0139	0278	0418	0557	0696	0835	0974	1114	1253	1392
09	0156	0313	0469	0629	0782	0938	1095	1251	1408	1564
10	0174	0347	0521	0694	0868	1042	1215	1389	1562	1736
11	0191	0382	0572	0763	0954	1145	1336	1526	1717	1908
12	0208	0416	0624	0832	1040	1248	1456	1664	1872	2079
13	0225	0450	0675	0900	1125	1350	1575	1800	2025	2249
14	0242	0484	0726	0968	1210	1452	1694	1936	2288	2419
15	0259	0518	0776	1035	1294	1553	1812	2070	2329	2588
16	0276	0551	0827	1102	1378	1654	1930	2205	2481	2756
17	0292	0585	0877	1169	1462	1754	2046	2339	2631	2924
18	0309	0618	0927	1236	1545	1854	2163	2472	2781	3090
19	0326	0651	0977	1303	1628	1954	2280	2505	2831	3256
20	0342	0684	1026	1368	1710	2052	2394	2736	3087	3420
21	0358	0717	1075	1433	1792	2150	2509	2867	3226	3584
22	0375	0749	1124	1498	1873	2248	2622	2997	3371	3746
23	0391	0781	1172	1563	1954	2344	2735	3126	3516	3907
24	0407	0813	1220	1627	2034	2441	2847	3254	3661	4067
25	0423	0845	1268	1690	2113	2536	2959	3381	3804	4226
26	0438	0877	1315	1753	2192	2630	3069	3507	3946	4384
27	0454	0908	1362	1816	2270	2724	3178	3632	4086	4540
28	0469	0939	1408	1878	2347	2817	3286	3756	4225	4695
29	0485	0970	1454	1939	2424	2909	3394	3878	4363	4848
30	0500	1000	1500	2000	2500	3000	3500	4000	4500	5000
31	0515	1030	1545	2060	2575	3090	3605	4120	4635	5150
32	0530	1060	1590	2120	2650	3179	3709	4239	4769	5299
33	0545	1089	1634	2178	2723	3268	3812	4357	4901	5446
34	0559	1118	1678	2237	2796	3355	3915	4474	5033	5592
35	0574	1147	1721	2294	2868	3442	4015	4589	5162	5736
36	0588	1176	1763	2351	2939	3527	4114	4702	5290	5878
37	0602	1204	1805	2407	3009	3611	4212	4814	5416	6018
38	0616	1231	1847	2463	3078	3695	4310	4926	5542	6157
39	0629	1259	1888	2517	3147	3775	4405	5034	5663	6293
40	0643	1286	1928	2571	3214	3857	4499	5142	5785	6428
41	0656	1312	1968	2624	3280	3937	4593	5249	5905	6561
42	0669	1328	2007	2677	3346	4015	4684	5353	6022	6691
43	0682	1364	2046	2728	3410	4092	4774	5456	6138	6820
44	0695	1389	2084	2779	3473	4168	4863	5558	6252	6947
45	0707	1414	2121	2828	3536	4243	4950	5656	6365	7071

The Decimal Table.

D	10	20	30	40	50	60	70	80	90	100
89	0999	2000	3000	3999	4999	5998	6998	7998	8998	9998
88	0999	1999	2998	3998	4997	5996	6996	7994	8994	9994
87	0999	1997	3996	3995	4993	5989	6988	7987	8986	9986
86	0998	1995	2993	3990	4988	5986	6984	7983	8972	9976
85	0996	1992	2989	3985	4981	5977	6973	7970	8966	9962
84	0995	1989	2983	3978	4973	5962	6957	7952	8947	9945
83	0993	1985	2978	3970	4963	5953	6946	7939	8932	9925
82	0990	1981	2971	3961	4951	5940	6931	7922	8912	9903
81	0988	1975	2963	3951	4938	5925	6913	7901	8892	9877
80	0982	1969	2954	3939	4924	5909	6894	7878	8863	9848
79	0982	1963	3945	3926	4908	5890	6871	7853	8834	9816
78	0988	1956	2934	3913	4891	5869	6847	7825	8803	9781
77	0975	1949	2923	3897	4872	5846	6821	7795	8770	9744
76	0970	1941	2911	3881	4851	5821	6792	7762	8773	9703
75	0966	1932	2898	3864	4830	5796	6762	7728	8694	9659
74	0961	1923	2884	3845	4806	5768	6729	7690	8652	9613
73	0256	1913	2869	3825	4782	5737	6694	7650	8607	9563
72	0951	1902	2853	3804	4755	5706	6657	7608	8559	9511
71	0946	1891	2836	3782	4727	5673	6618	7563	8510	9455
70	0240	1878	2818	3758	4697	5638	6578	7518	8457	9397
69	0934	1867	2801	3734	4668	5600	6533	7467	8401	9336
68	0927	1854	2782	3709	4636	5564	6489	7416	8344	9272
67	0921	1841	2761	3682	4602	5520	6441	7362	8284	9205
66	0914	1827	2741	3654	4568	5478	6392	7306	8221	9135
65	0906	1813	2719	3625	4531	5434	6341	7248	8156	9063
64	0899	1798	2696	3595	4494	5390	6290	7189	8088	8988
63	0891	1782	2673	3564	4455	5343	6235	7126	8018	8910
62	0883	1766	2649	3532	4414	5295	6179	7062	7946	8829
61	0875	1749	2624	3498	4373	5247	6122	6997	7872	8746
60	0866	1732	2598	3464	4330	5196	6062	6928	7794	8660
59	0857	1714	2572	3429	4286	5142	5999	6857	7714	8572
58	0848	1696	2544	3392	4240	5086	5934	6783	7631	8480
57	0839	1677	2516	3355	4193	5029	5869	6708	7548	8387
56	0829	1658	2487	3316	4145	4971	5801	6630	7460	8290
55	0819	1638	2457	3276	4095	4912	5732	6552	7372	8192
54	0809	1618	2427	3236	4045	4851	5661	6470	7280	8090
53	0799	1597	2396	3194	3993	4779	5576	6372	7169	7986
52	0788	1576	2364	3152	3940	4726	5514	6303	7091	7880
51	0777	1554	2331	3109	3886	4661	5439	6216	6994	7771
50	0766	1532	2298	3064	3830	4596	5362	6128	6894	7660
49	0755	1509	2264	3019	3774	4528	5283	6038	6792	7547
48	0743	1486	2229	2973	3716	4461	5203	5946	6688	7431
47	0731	1463	2194	2925	3657	4392	5122	5853	6581	7314
46	0719	1439	2158	2877	3597	4348	5072	5796	6522	7193
45	0707	1414	2121	2828	3536	4243	4950	5656	6365	7071

The Description, Use, and Construction of the foregoing Decimal Table, *for the finding of the* Easting *and* Westing, Northing *and* Southing *of any Line, the Length and Bearing being given. And also the* Horizontal *and* Perpendicular Line *of any Hill*, &c.

I. *The Description.*

THIS *Table* is so ordered, as to be in two Pages, the one facing the other, so that both Pages may be seen at one view; the Left-hand Page having the first 45 Degrees of the *Quadrant* in a little Column on the Left-side thereof, and beginneth at the top, and is numbred downward, beginning with 1, 2, 3, *&c.* and ending with 45. And this Page hath also ten Columns more towards the Right-hand, which are noted at the Head with 10, 20, 30, *&c.* to 100, over the last Column. And as the Left-hand Page is noted at the Head, so is the Right-hand Page also; and hath a little Column also towards the Left-hand, which is numbred upwards, as the other was numbred downwards; and it hath the Degrees answering to the other half of the *Quadrant, viz.* from 45 to 90 Degrees, accounted upwards, for the readier finding the Complement of any Number of Degrees to 90, for the convenience of taking out the Numbers answering to any Degrees, and the Complement of the same Degrees, both at one view. The Use of this *Table* will more plainly appear by the Examples following, than by using of many Words for the explaining of it.

II. *The Use of the* Table.

Example 1. The following *Figure* VII. is the *Plot* of a large Wood near *Hornsey*, and adjoining to a place called *Copt-Hall*, which is called by the name of *Brown's Wood.*

Fig. VII. The Lines of the Sides are noted with A B C D E F G, as you see the pricked Lines of the outside of the *Plot* between Letter and Letter; and the black Lines within the pricked ones are the Bounds of the Wood; and the short pricked Lines which touch the other pricked at Right Angles, are Perpendicular Sets off from the Chain Line to the outside of the Wood.

There are two other pricked Lines; the one noted with *N. S.* which signifieth the *Meridian*, or *North* and *South*; the other noted with *E. W.* which sheweth the *East* and *West* parts of the *Plot* of the Wood: and these Lines intersect or meet one another in the Point A. And if a Line be drawn parallel to *N. S.* through the Point B, that will also be a *Meridian* Line, and shew the *North* and *South* parts of the *Plot*: and then from the Line *East, West*, draw also a Line parallel, cutting the Point B; and that will shew the *East* and *West* sides of the *Plot*. And in the like manner you may continue the drawing of Parallel Lines from the *North* and *South*, and *East* and *West*, to all the *Angles* of the *Plot*, or any other, if you list to take that pains.

Then having provided a *Field-Book*, in form of that which followeth, divided and ruled into 8 Columns, you may proceed to the Field-Work in manner following, *viz.*

First, Placing your *Instrument* at A, and the *Flower-de-luce* towards you, direct your Sights to B, and observe what Degrees the *South* end of the Needle cutteth, which I find to be 37 Degrees, and beareth from the *North* towards the *West* 37 Degrees, as by the *Plot* and the Line of *North* and *West* from the Point A is discovered. And you may very easily discern that the Line A B lieth nearer to the *North* than the *West*, and therefore the *North* Column must have the bigger Number; and for the bigger Number you must always use the bigger *Angle*; which in this case is the Complement of 37 Degrees to 90 Degrees, which is 53 Degrees. Then measure the distance of the *Instrument* from the corner of the Wood, it being here Perpendicular to the corner: but if the *Instrument* had been set up before you come to the Perpendicular let fall from the corner of the Wood upon the measured Line, then you must measure so far of the measured Line, till there will a Perpendicular fall from the

Fig. I.

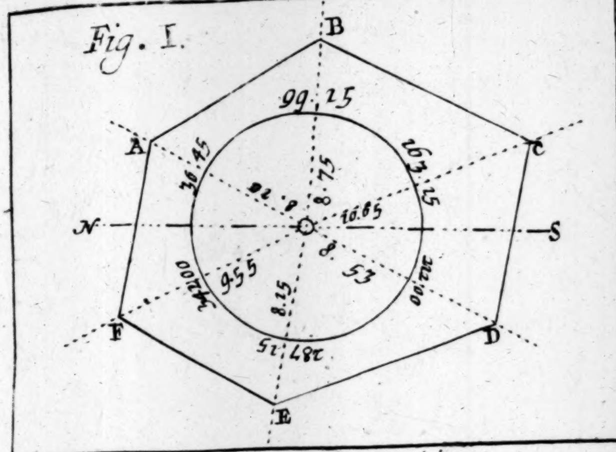


Fig. II.

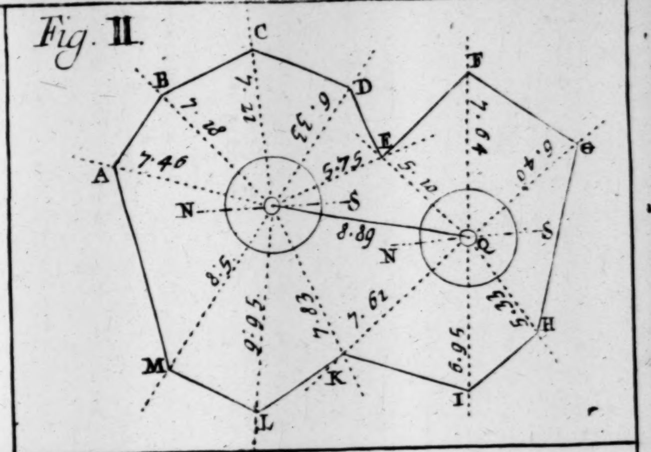


Fig. III.

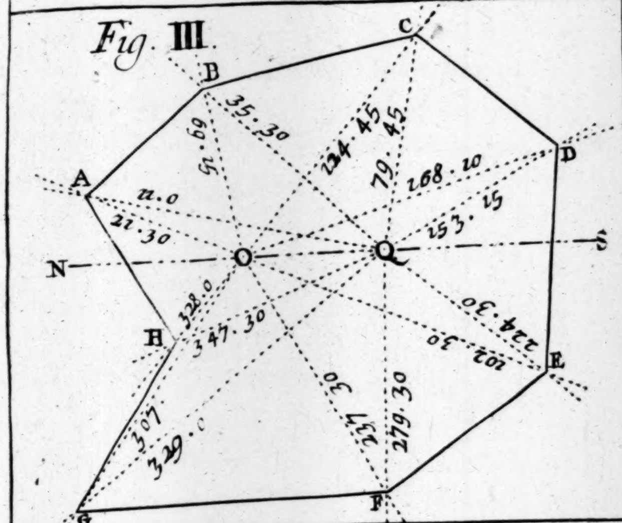


Fig. IV.

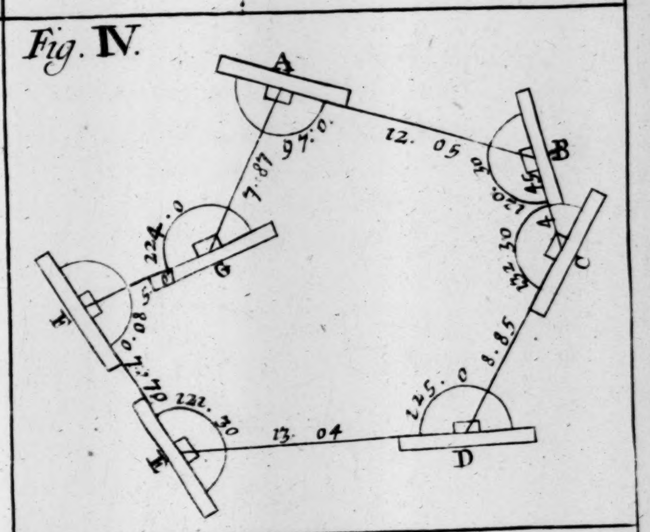


Fig. V.

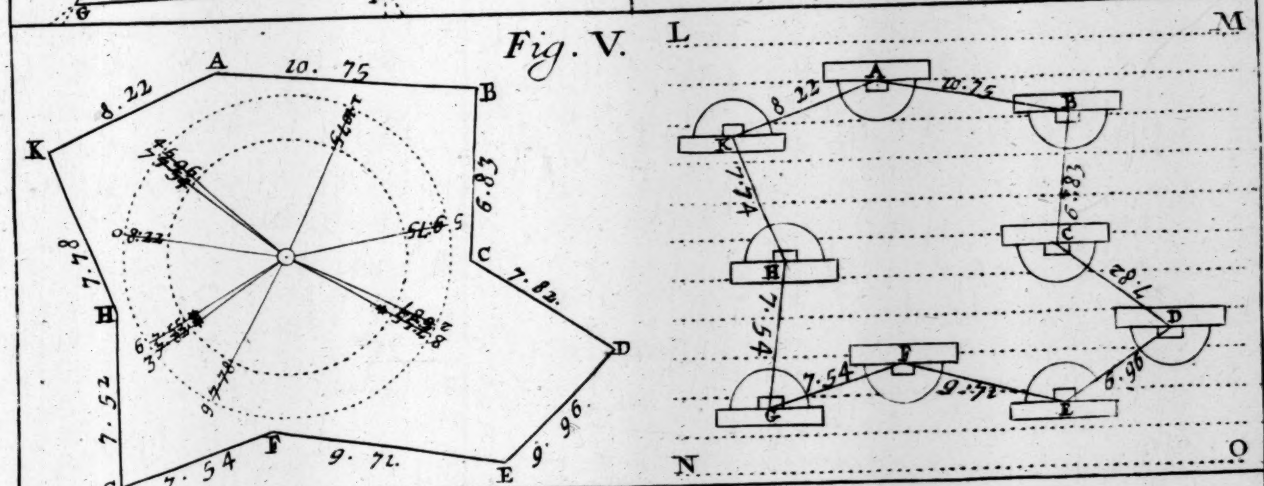
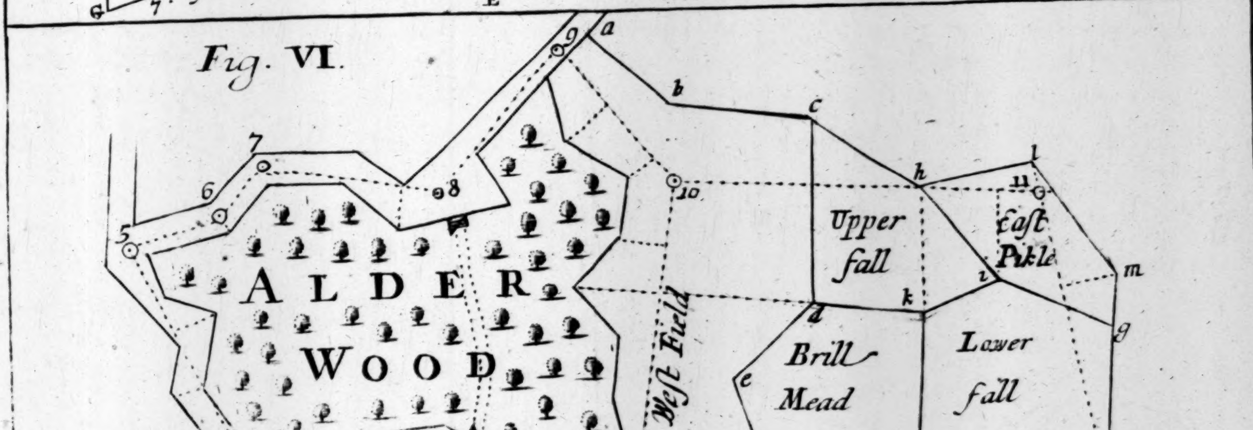


Fig. VI.



Against Pa. 374 to fold out.

the corner of the Wood or Field upon the measured Line. Then count how much of the measured Line cometh to that Perpendicular, and note that down in the Column provided for the Chain Line; and then measure the distance from the place the Chain was accounted from the *Instrument*, and set that down in another Column fitted for that purpose, for Sets off, either on the Left or Right-hand. And as in this *Plot* all the Sets off are to the Right-hand, the distance from the *Instrument* to the corner of the Wood at A is 1 Chain and 60 Links, which I set down in a Column on the Right hand of the Chain-Line Column, and Cyphers in the room of Chains and Links; signifying there was no part of the Line A B measured where that Perpendicular fell. Then measure from A to the next Perpendicular at Number 1, which is 7 Chains 00 Links: this must be put in the Chain-Column under the Cyphers. Then measure the distance from the Chain to the Bounds of the Wood, 1 Chain 73 Links, and put that in the next Column under 1 Chan 60 Links. Then measure from 1 to the Number 2, which is from A 10 Chains and 60 Links, which must be placed under 7 Chains 00; and there the distance from the Wood is nothing; therefore place Cyphers in the next Column, under 1 73. Then from A to 3 is 14 Chains 00 Links, which place under 10 60, and measure the distance from thence to the Bounds of the Wood, which is 80 Links, which put in the next Column under 0 00. Then from A to 4 is 16 Chains 80 Links, which place under 14 00, and at that place the distance of the Bounds of the Wood, which is 88 Links; place 88 under 80 in the next Column. And from A to 5 is 19 Chains 60 Links; then put 19 60 under 16 80, and there take the distance of the Bounds of the Wood, which is 1 Chain 06, which place under 0 88, and proceed to the Number 6. The distance from A to B is 29 Chains 40, which place under 19 60, and find the shortest distance of the Bounds of the Wood, which is 1 Chain, which place in the next Column: and then put 29 40 under 29 40, and take the greatest distance, which is 1 Chain 92: which place under 1 00, and by that means, when you come to Plot the Wood, you will have that break at Number 6. (But if the break had been the contrary way, then you should have taken the greatest distance first, and set down the number of Chains and Links from A; and then afterward taken the shortest distance, and against it in the Chain-Line set down the distance from A: and by using of this method you will not be subject to mistake, whether the break standeth from you or cometh towards you.) Then having finished my work at Number 6, I measure forward to the Beacon placed at B, and I find the distance from A to B is 35 Chains and 20 Links, which I place under 29 40; and then measure the distance from the Beacon in a Perpendicular Line to the Bounds of the Wood, which is 1 Chain and 96 Links, which must be placed under 1 92: then is the Line A B finished.

Then take down the Beacon and set it up at C, and place the *Instrument* at B, where the Beacon stood; and putting the *Flower-de-luce* towards you, direct the Sights to C, and you will find that the *South* end of the *Needle* will stand over 71 Degrees from the *South* towards the *West*; and therefore the *West* Column must have a great deal the bigger Number, as the proportion of the Sine of 19, the Complement of 71, and the Sine of 71 require. Then place down this 71 Degrees in its proper Column, and *S. W.* with it, to signifie that the Line is *South west* 71 Degrees. Then measure the distance from the *Instrument* to the Bounds of the Wood in a Perpendicular Line to B C, and note it down as you did in the Line A B. Then, as you measure towards C, take notice of the Perpendiculars as you pass by, and set them down in the same order as you did in the Line A B: and having set them down in order in your *Field-book*, and measured to the Beacon at C, which is 10 Chains 20 Links, and the Perpendicular nothing; then is the Line B C finished.

Then take down the Beacon at C, and set it up at D, and place the *Instrument* where the Beacon stood at C, and bring the *Flower-de-luce* towards you, and direct the Sights to D; the *Instrument* being set level, you will find that the *South* end of the *Needle* will rest over 18 Degrees *Westward* of the *North*; which must be noted in your *Field-Book* thus, 18 D. N. W. And here the *North* Column must have the bigger Number; the Line C D being nearer the *North* than the *West*, must be the bigger Number, and longer Line. Then measure from C to D, which is 17 Chains and 20 Links; taking notice of the Perpendicular Sets off as you go along, as you were directed in the Line A B, and enter it into your *Field-Book* accordingly.

Then

Then remove the *Instrument* to D, and place it where the Beacon stood, and set up the Beacon at E; then turn the *Flower-de luce* towards you, and direct your Sights to E, and the *South* end of the *Needle* will cut 52 Degrees *Eastward* from the *North*: therefore you must enter in your *Field Book* 52 D. *N. E.* And here the *East* Column must have the bigger Number; for 52 being more than 45, the Line D E is more *East* than *North*: for if the Degrees of bearing be just 45, the Number in both Columns is alike.

Then measure from D towards E, until you come against the Perpendicular of the corner of the Bounds of the Wood; and in this *Plot* we go forward 88 Links before we come to the Perpendicular of the Wood corner: then set down 00 88 in the Chain-Column, and measure how far it is in that place to the Chain-Line, which will be found to be 50 Links; which must be put into the next Column, as you did in the Line A B.

Then measure to the Beacon at E, and as you pass by take an account of the Length of the Line to that corner of the Wood, which is 20 80, and the distance there from the corner of the Wood 50 Links: set them both down as you did the other, and measure to the Beacon at E, which is 21 10; which enter in the *Field-Book*, and the Line D E is finished.

Then remove the *Instrument* to E, and the Beacon to F, and turning the *Flower-de-luce* towards you, direct the Sights to F, and the *South* end of the *Needle* will cut 38 Degrees, which is from the *South Eastward*, and must be noted down in your *Field-Book* thus, 38 D. *S. E.* or thus, *S. E.* 38. This 38 being less than 45 to the *Eastward*, the Line E F will be nearer to the *South* than to the *East*, and the *South* Column must have the bigger Number. Then measure from E to the corner of the Wood 50 Links, and the distance is also 50 from the corner, as you may plainly see in the *Figure* of the *Field-Book* following. So going forward, and taking an account of all the Perpendicular Sets off from thence to F, as they are noted in the *Field Book*.

Then remove the *Instrument* to F, and the Beacon to G, and bring the *Flower-de-luce* towards you, and direct the Sights to G, and the *South* end of the *Needle* will cut *South-East* 22 Degrees: which place in your *Field-Book* as before, and measure the Line F G as you did the others, and put it in the *Field-Book*.

Then remove the *Instrument* to G, and the Beacon to A, and the *Flower-de-luce* standing towards you, and the Sights directed to A, the *South end* of the *Needle* will stand *South-West* 50 Degrees; which note in your *Field-Book* thus, *S. W.* 50 D. Then measure the Line G A, and take P. the Perpendicular Sets off, as you go along; and enter this Line in your *Field-Book*, as you did in the other; and they will stand as in the *Figure* of the *Field-Book* is expressed.

This *Field Book* hath Eight Columns. The First of them towards the Left-hand is for the Bearing of any Line from the *North* or *South*, *Eastward* or *Westward*, and the number of Degrees that the Line differs from the *Meridian*; as in the first Line of the *Figure*, A B is *Westward* from the *North* 37 Degrees, as you see noted in the upper part of the first Column. The Second Column is noted at the Head with Per. S. which signifie Perpendicular Sets off towards the Left-hand, which will many times happen, although in this Example all the Sets off are to the Right-hand; but many times in measuring through Lanes, it will be convenient to take Sets off on both sides, and therefore have a Column for both hands. The Third Column is noted at the Head with C. L. which signifies Chains and Links: and in that Column is set down in Chains and Links the distance from the *Instrument* to any Break, or Perpendicular Set off, in all the Lines that enclose the Wood, or any other parcel of Ground. And the Fourth Column is for the same use as the Second, only the difference of Left and Right-hand Sets off, as is before declared in the measuring of the Line A B. The other Four Columns are noted at Head in this order, *North. South. East. West.* and are for no other use, but to set down how far any Line goeth upon any of those Points.

Having finished your Work in the *Field*, lay your *Field-Book* before you; wherein you shall find your first Bearing to be *N. W.* 37 Degrees, and the Length of your first Stationary Line, A B, to be 35 Chains 20 Links.

Now repair to your *Decimal Table*, and look for 37 Degrees in the first Column of the Left-hand Page; against which (and under 30, for 30 of your Chains) you shall find 1805, and in the same Line under 50, (for the 5 Chains) you shall find 3009, which set under 1805 one place backwards: Then for the 20 Links, look

in

The Figure of the Field Book.

Bearing	D.	Per. S.	C.	L.	Per. S.	North.	South.	East.	West.
N. W.	37		00	00	1 60				
			07	00	1 73				
			10	60	0 00	23.96			18.05
			14	00	0 80	3.993			3.009
			16	80	0 88	1597			1204
			19	60	1 06				
			29	40	1 00				
			29	40	1 92				
			35	20	1 96				
S. W.	71		00	00	0 48		03.256		09.495
			02	00	0 00		0651		0651
			06	80	1 20				
			09	00	0 80				
			10	20					
N. W.	18		00	00	0 00	09.511			03.090
			04	40	1 40	6.657			2.163
			13	20	0 00	1902			0618
			16	75	0 60				
			17	20	0				
N. E.	52		00	00	0 00	12.31		15.76	
			00	88	0 50	0616		0788	
			20	80	0 50	0616		0788	
			21	10					
S. E.	38		00	00	0 00				
			00	50	0 50				
			02	40	0 00		23.64	18.47	
			06	00	0 80.		2364	1847	
			13	70	0 40		3152	2463	
			17	60	0 50				
			21	40	1 00				
			26	80	2 80				
			33	40	0 40				
S. E.	22		00	00	0 40				
			03	70	0 00		18.54	07.49	
			15	00	0 90		0.927	0.375	
			21	40	0 40		5564	2248	
			21	60					
S. W.	50		00	00	0 00				
			00	30	0 20		06 43		07.66
			02	40	0 00		0.643		0.766
			05	60	0 30		4499		5362
			10	40	0 00				
			11	70					
		The Summ, is				57.3585	57.1866	45.2799	45 0165

in the same Line (of 37 deg.) under 20, and there you shall have this 18.05
Number 1204, which set under the other, still one place backward: All 3.009
which Numbers must be set in this Order, under the West Column of .1204
the Field-Book; and so will they stand there as you see them stand in 21.1794
the Margin, and their Summ is 21.1794.

Also look in the Right-hand Page of the Decimal Table, for 53 deg.
(the Complement of 37 d.) and against 53, and under 30, (for 30 Chains,)
you shall find 2396; and in the same Line, under 50, (for the 5 Links,) 23.96
3993, which set under the other; and in the same Line, under 20, (for 3.993
the 20 Links,) you shall find 1597, which set under the two other, which .1597
are to be placed in the North Column, as in the Margin, whose Summ is
28.1127. And these Numbers you shall find stand in the North and 28.1127
West Columns of your Field-Book, because the Bearing was North-West: And thus must you doe with all the Bearings, as is done in the Figure of the Field-Book. Which done, add up each Column; and if the North and South are both equal, and the East and West also equal, then you may be sure that the Work is exactly done, and the Degrees of Bearing truly taken, and the Lines also truly measured. But in this Example there is a quarter of a Chain difference between the East and West, and 17 Links difference betwixt the North and South; which in this large Wood is not very material, by reason we use all whole Degrees. And this small Error may very easily be mended in the plotting of the Chain-Lines. But if you use an Instrument that you can discern Halfs or Quarters of a Degree, or Tenth parts of a Degree, if possible, then if you make use of this Table, you must make proportion for the Minutes; but if you make use of a Table of Natural Sines, the Work may be done by one Multiplication for each Column, which will plainly appear as followeth.

Example II. *How by a Table of Natural Sines, to supply the Use of the foregoing Decimal Table.*

If the Line A B had been N. W. 37 Degrees 15 Minutes, or one quarter of a Degree, the Natural Sine thereof is 605294; which being multiplied by the Length of the Line 3520, produceth 21.30634880, which is 21 Chains 30 Links, and a little more than half, for the West Column. Then to find the Number for the North Column, subtract 37 Degrees 15 Minutes from 90 Degrees, and the Remainder is 52. 45: Then look the Natural Sine thereof, which is 7960, (the four first Places thereof:) then multiply 7960 by 3520, and the Product will be 28.019200, which is 28 Chains and almost 2 Links for the North Column, And by this you see how far the Line goeth North, and how far West. But by reason all Persons may not be furnished with a Canon of Natural Sines, it may be as well done by two Additions in the Sines and Logarithms in the Third Book, where you may be furnished with every 10 Minute, and the Logarithms to 1000, which will very well serve for short Lines, or small Inclosures; but the Line in the last Example is fitter to be done by a larger Canon, as in the next Example.

Example III. *How to perform the Work of the foregoing Example by the Tables of Artificial Sines and Logarithms.*

First, take out the Sine and Co-sine of the observed Angle, and set them down as followeth.

Sine 37 Degrees 15 Minutes,	9,7819664.	Co-sine,	9,9009142.
Logarithm of 35. 20.	1,5465426.	Log.	1,5465426.
Number 21. 31.	1,3285090.	28. 02.	1,4474568.

Having thus set down the Sine and Co-sine, then look the Logarithm of 35 Chains and 20 Links, and set it down under the Sine and Co-sine, and add the Logarithm to the Sine and Co-sine: Then look into the Tables of Logarithms for the nearest Logarithm that you can find to these Numbers, and the Numbers answering to those Logarithms is the Number in Chains and Links; for the North Column is 28. 02, and the Number for the West Column is 21. 31. And so you may readily find how

far

far any Line goeth North or South, East or West, by Addition only, as you see by this Example.

Example IV. *How to find the Horizontal Line of a Hill by this Decimal Table.*

Let the pricked Lines A H and B H in *Figure* VII. represent some Hill whose Altitude is 37 Degrees, and the Length of the Line A H be 28 Chains, and the Angle A B H 53 Degrees, and the Line B H 21 Chains 36 Links: Then by the foregoing Decimal Table find the Line A O by the Complement of the Angle at A, *viz.* 53 Degrees, and answering to the Line A H, 28 Chains. First, against 53, and under 20, I find 1597; and against 53, and under 80, which I tak for 8, I find 6372: Place them as you see in the Margin, and add them together, and they will stand thus: So part of the Horizontal Line of the Hill, from A to O, is 22 Chains and 34 Links; the other part will be as easily found by the Complement at B, which is 37 Degrees, and the length of the Line B H, 21 Chains and 36 Links. *Fig.* VII.

1597
6372
22.342

First, find 37 Degrees in the little Column on the Left-hand Page, and under 20 at Head you may find 1204; and in the same Line, under 10, which I make use of for 1, you may find 0602; and in the same Line, under 30, may be found 1805; and farther in the same Line, under 60, which is used for 6, may be found 3611; which you must place all in order, one place farther towards the Right-hand, each Number as they stand in order in the Margin; then add them together, and their Summ will be, as you see, 12 Chains and almost 86 Links; and to this part add the former, which you found for A O, and their Summ will be 35 Chains and 20 Links, which is the whole Base-line of the supposed Hill, or the true Length of the Line A B, as it was first measured. And by the same way of working, the Horizontal Lines of any Hill that can be measured over, although you have 10 or 20 Stations in going up, and as many in coming down, yet by this Table all the Horizontal Lines may be found by Addition, and the whole Length of the Base gained by many, as well as this of two Stations: The Line that goeth over the Hill supposed, is 49 Chains and 36 Links, and the Horizontal or Base-line thereof is but 35 Chains and 20 Links. I hope you may as well understand, by the supposing of these Lines to be a Hill, as if they had been a Real Hill.

1204
0602
1805
3611
12.85861
22.342
35.20061

Example V. *How by this Table you may find the Perpendicular Line of any Hill that you can measure up or over, as is supposed in* Figure VII. *before treated of, marked with* H O.

For the finding the Perpendicular Height of any Hill, the Altitude being taken, and the Line to the top measured, as in the former Figure, the Angle at A being 37, and the Line A H 28 Chains; First, against 37 Degrees, and under 20, may be found 1204; and under 80, in stead of 8, in the same Line is 4814; which being placed as in the Margin, will stand thus; and being added together, will make 16 Chains 85 Links and almost a half; and so much is the Perpendicular Line O H, which is the Height of the supposed Hill. And after the same manner the Perpendicular Height of any Hill may be obtained.

1204
4814
16.854

I Thought here to have concluded with *Surveying*; but forasmuch as there is an Ancient Instrument, called the *Plain Table*, much used by some, whose Plainness makes it so common, (but he that uses it, shall find it very tedious, and not at all times fit to be used,) I shall exemplifie the Use thereof in one Example, according to the Method used by my very loving Friend Mr. *Vincent Wing*, an able Astronomer and Surveyor, and the greatest Lover of this Instrument I ever met with; and therefore I shall here insert an Example of his own.

CHAP.

CHAP. XIV.

How to take the Plot of a Field by measuring from one Angle to another, round about the same.

Fig. VIII. SUppose this Irregular Figure A B C D E F G H I K L S to represent a Field, into which when I first enter, I cause Whites to be set up in every Corner of the same; which done, I make choice of the most convenient Angles thereof for my Stations, not regarding their number, whether I make three, four, five, or six Stations, yet the fewer the better: but you must always take so many, as you may clearly see from one Station to another. Thus in the former Figure I make choice of my first Station at X, as a Place most fit for my purpose, in regard that from thence I can see the Point S; and therefore I send one with a Beacon to S, so as when I go on in the Line X S, I may take a Tangent at B: Then planting my Table at X, I direct my *Index* to D, and strike the Line X D, which I measure, finding it $5^p\ 30^l$; and this I set down from X to D, and so make a Prick at D. This done, I direct the *Index* to S, and strike the Line X S; then I measure on in the said Stationary Line, till I come to Z, $47^p\ 30^l$ from X, where laying my *Index* upon the Line S Z X, I direct the Sights to X, and there fix the Table with the Screw-pin. Then turning the *Index* upon the Point Z, till through the Sights I espie the White at C, I strike the Line Z C, and finding the Distance $13^p\ 50$, I set it down from Z to C, where I make a Point, and draw the Line D C. Then I go on with my former Measure, till I come to B $68^p\ 40$, and there I make a Point, and draw the Line C B; which done, I go on carefully with my former Measure, till I come to the place of my second Station at S, finding the Stationary Distance X S $95^p\ 10$, which from my Scale I apply from X to S, where I make for my second Station such a Mark as this, (⊙). Then planting my Table there, I direct my Sights to A ♁ and L, and I find S A $13^p\ 0$, S ♁ $9^p\ 0$, and S L $3^p\ 0$, which set down severally upon their respective Lines, I have the Points A, ♁, and L, upon the Paper. Then drawing the Lines A B, A ♁, and ♁ L, we have one Side of the Field described.

Secondly, I plant my Table at S, and laying the Fiducial Line of the *Index* upon the Line S X, I move the Table, till through the Sights I espie the Point X; then fixing my Table, I turn my *Index* about upon the Point S, till through the Sights I see the Beacon at P, and by the Edge of the *Index* I draw the Line S P; which done, I proceed, and measure on the Stationary Distance; but as I go on, and am come to T, 35^p from my second Station, I observe I am in a manner against the Angle K; wherefore I plant my Table there, and direct the Sights to K. Then I measure the Distance, finding it $7^p\ 50$, which I set down from T to K, and draw the Line L K; which done, I continue my former Measure S T to P, and finding it $52^p\ 0$, I set it down from S to P, where again I make such a Mark (⊙).

Thirdly, I plant my Table there, and laying my *Index* upon the Line α P S R, I turn the Table about, till through the Sights I see the Place of my second Station S: Then (the Table being there fixed) I direct the Sights of my *Index* from P to I, and finding it (by the Chain) to contain $4^p\ 60$, I set it down from P to I; which done, I describe the Line K I with the Point of my Black-lead Pencil, as before. Afterwards, from P, I direct the Sights to my next Station at G, and draw the occult Line P G: Then I measure on with my Chain from P towards G, and when I come to N $37^p\ 10$, (where I make a Prick with the Point of my Compasses,) I perceive I am almost against the Angle H; then laying my *Index* upon the Line P G, I turn the Table, till I espie G with the Fore-sight, and P with the Back-sight, (by which you may know whether you be exactly in the Line or no:) Which done, fix your Table, and direct your Sights from N to H, pricking down the Distance $7^p\ 40$, and so with your Pencil describe the Line I H: And after this is done, continue on your former Measure begun from P, till you come to G, (your next Station,) which you shall find to be $85^p\ 0$, which set down to G, and mark it again thus, (⊙).

Lastly, At G plant your Table, and lay the *Index* exactly upon the Line Y G P ♈: Then turn the Table gently, (for fear of shaking the *Index* off of the Line,) till through the Sights you espie the Beacon at P; which done, fix your Table, and remove the *Index*, directing the Sights from G to the place of your first Station at X, where

where you began; and if it cut the Mark, it is very probable that your Plot is exact. Then I measure on towards X, and when I have gone to O, $18^p\ 60$ from G, I describe the Angle F, drawing the Line G F; and measuring still on, I find the Tangent Point E, 39^p from G, which I note with the Point of my Compass, drawing the Lines F E and E D; which done, I continue on my former Measure in the Line G X, finding it to be exactly $65^p\ 90$: Then, because the same Extent taken from the Scale fals upon the Plot precisely in the Point X where I first began, it is an infallible Sign that the Plot of the Field is exactly taken.

CHAP. XV.

The Plot of a Field being taken by any of the forementioned Ways, to find the Content thereof in Acres, Roods, and Perches.

IN the Treatise of the Mensuration of Geometrical Figures, there is taught how to measure all sorts of Plain Figures, both Regular and Irregular; so that to say any thing of that in this place, were superfluous: Yet (because Land is measured by a Chain particularly designed for Land-measure, such an one as is described before, in the Fourth *Paragraph* of the VI. *Section* of *Chap.* I. of *Longimetria*,) I will give you One Example thereof.

I. *How to Multiply Chains and Links by Chains and Links.*

Multiply the Numbers one by another, as is largely taught in *Decimal Arithmetick*; but in this, although you make a Point or Prick to separate the whole Chains from the Links, yet you are not to cut off just so many Figures of your Product as there are Figures behind the Points in the *Multiplicand* and *Multiplier*, which for the most part will be four Figures, but (always) five Figures must be cut off from the *Product*; and if there be not so many Figures as five in the *Product*, you must then make them up five, by adding Cyphers before them. I will here give you Examples in all Cases ready wrought, which will give more Light to the Thing intended, than many Words.

Example I. Multiply 27 Chains 53 Links by 8 Chains 25 Links.

Here the Product is 22 Acres and .71225 parts of an Acre.

	Ch. Lin.
	27. 53
	8. 25
	13765
	5506
	22024
	22.71225

Example 2. Multiply 12 Chains 9 Links by 7 Chains 15 Links.

Here the Product is 8 Acres and .64435 parts of an Acre.

	Ch. Lin.
	12. 09
	7. 15
	6045
	1209
	8463
	8.64435

Example 3. Multiply 23 Chains 80 Links by 4 Chains.

Here the Product is 9 Acres and .52000 parts of an Acre.

	Ch. Lin.
	23. 80
	4. 00
	9. 52000

	Ch. Lin.
Example 4. Multiply 1 Chain 25 Links	1. 25
by 0 Chains 15 Links.	0. 15
	625
	125
Here the Product is .01875 parts of an Acre.	.01875

	Ch. Lin.
Example 5. Multiply 27 Links	0. 27
by 8 Links.	0. 08
Here the Product is .00216 parts of an Acre.	.00216

These are all the varieties that can at any time happen; and (always) the Figure or Figures to the Left-hand are whole Acres, and the Figures to the Right-hand of the Point are $\frac{.32794}{100000}$ parts of an Acre, which must be reduced into Roods and Perches, as followeth.

II. *How to reduce the Fraction Parts of an Acre into Roods and Perches.*

You are to understand, that in an Acre there are 160 Square Perches, each Perch containing 16.5 Foot in length; so that in one Square Perch there are 272.25 Square Feet, and so in an Acre 43560 Square Feet: Also in one Rood is contained 40 Perches; so that a Rood contains 10890 Square Feet. And now to reduce the Decimal Fraction Parts of an Acre into Roods and Perches, this is the

RULE.

Multiply the Fraction Part (always) by 40, and from that Product cut off (always) five Figures; the Figures to the Left-hand of the Point are Whole Roods, and the five Figures to the Right-hand are Decimal Parts of a Rood; which multiply by 40, and from the Product cut off five Figures; so shall the Figures to the Left-hand be Whole Perches, and the Figures to the Right-hand Parts of a Perch.

Example. In the first Example beforegoing, which was 27 Chains 53 Links, multiplied by 8 Chains 25 Links, the Product whereof was 22.71225, which is 22 Acres .71225 Parts, which multiplied by 4, the Product will be 2.84900, that is, 2 Rood and .84900 Parts of a Rood, which multiplied by 40, the Product will be 33.96000, that is, 33 Perches and .96000 parts of a Perch; which may well be called 34 Perches, because .960000 is very near 1.00000: And so may you always doe, when the first Figure of the Fraction remaining is either 7, 8, or 9. And thus if this were a Piece of Land lying in a long Square, and being 27 Chains 53 Links in Length, and 8 Chains 25 Links in Breadth, the Content thereof will be 22 Acres, 2 Roods, and 34 Perches, as is evident by the Work.

	Ch. Lin.
	27. 53
	8. 25
	13765
	5506
	22024
Acres	22.71225
	4
Roods	2.84900
	40
Perches	33.96000

III. *The Plot of any Piece of Land being taken, according to any of the ways before prescribed, to find the Content thereof in Acres, Roods, and Perches.*

Fig. IX. Suppose the Irregular Plot A B C D E F G to be a Field Surveyed and Plotted by some of the former Directions, and the Content thereof were required: You must first by the Doctrine of the *Mensuration* of *Geometrical Figures*, reduce the

the Irregular Plot into *Trapezias* and *Triangles*, as is there taught; so shall this Plot, consisting of seven Sides, be reduced into two *Trapezias* and one *Triangle*, *viz.*

(1.) The *Triangle* A G F, noted with K.
(2.) The *Trapezia* A B E F, noted with L.
(3.) The *Trapezia* B C D E, noted with M.

The Lengths of the several Bases and Perpendiculars whereof, let be such as the Numbers set to them do contain in Chains and Links. Then shall,

(1.) Half the Base, A F, of the *Triangle* A G F, *viz.* 24 Chains 46 Links, multiplied by 10 Chains 65 Links, the Perpendicular G H, produce for the Content of the *Triangle* K ————————	26.04990
(2.) Half the Common Base of the *Trapezia* A B E F, *viz.* B F, 28 Chains 03 Links, multiplied by 40 Chains 92 Links, the Summ of the two Perpendiculars A N and E O, produce for the Content of the *Trapezia* L ————————	114.69876
(3.) Half the Common Base, C E, of the *Trapezia* A B E F, 25 Chains, multiplied by 32 Chains 50 Links, the Summ of the two Perpendiculars B P and D Q, produce for the Content of the *Trapezia* M ————————	81.25000
	221.99766

Which 221.99766 being reduced by the Directions of the two foregoing Sections, will be 221 Acres, 3 Roods, 39 Perches, and .62560 parts of a Perch, which may well be called 222 Acres, it wanting but the $\frac{37440}{1000000}$ part of a Perch thereof.

IV. *A Better and more Exact Way of Casting up of any large Irregular Ground, being Plotted, than the foregoing Way of Reducing the Plot into* Triangles.

In going about your Field, and making Observation at every material Angle thereof, you measure your Station-Line from one Station to another, and as you pass by any small Bow or Bending in the Hedge, you, (1.) Note against what Number of Chains and Links such a Bow or Bend is, and set that Number down in your Field-Book. (2.) You measure from your Chain up to that Bow or Bending, and note that Distance down in your Field-Book, in a Column by the side of the other Column, on the Right-hand, if your Hedge be on your Right-hand; or on the Left, if it be on the Left-hand. Then when you come to Plot your Field, you first lay down the Lines you measured in the Field, which will bring the greatest part of the Body of the Field into a large *Parallelogram*, or a Four, Five, or Six-sided Figure, consisting all of Right-lines, they being the same that you measured with your Chain; and this large Right-lined Figure must be cast up by the Rules last delivered, by dividing it into *Triangles* or *Trapezias*: But for the Casting up of the other Parts, which lie between the Chain-lines and the Hedges, if you reduce them into *Triangles*, they will be a great many in number, and being Lines not measured by your Chain, in taking the Bases and Perpendiculars with your Compasses, you shall very much mistake, both in laying them down first, and in taking them off afterwards, especially if the Scale you protract or lay down by be very small, where 10 or 12 Links of a Chain, (which is half a Rod,) is barely to be estimated, though your Scale be well divided, and the Points of your Compasses very small. For the remedying of this Inconvenience, I shall here shew you a Way, (not commonly used by Mercenary Surveyors,) whereby you shall cast up the Quantities of those Outlets without reducing of them into *Triangles*, (and so taking the Bases of them with your Compasses,) but by the Lines you really measured with your Chain, and then, let the Scale you Plot by be great or small, you shall have the true Quantity of those Out-lets as exact as any other part of the Field. An Example will make plain what I have here delivered.

Suppose that you have measured in the inside of a Field, by a Hedge lying on your Left-hand, a Chain-line containing 8 Chains 12 Links, which Line let be A B, and the Hedge is distant towards my Left-hand, from A, 25 Links of my Chain, which I note down in my Field-Book; and as I measure from A towards B, at 1 Chain 20 Links, I find a Bow in the Hedge, from which I measure with my Chain, and find the Distance thereof from my Chain to be 0 Chains 90 Links, which I set down, and going on forwarder, till I have measured 2 Chains 30 Links towards *Fig.* X.

towards B, I meet with another Bow in the Hedge, which is distant from my Chain, 1 Chain 05 Links, this I note down in my *Fleld-Book* also, and so all my other Lengths and Distances, as I find them in my passage from A to B: and when I come to B, my Observations as I made by the way, will be as in this *Table*; by which I Protract my Line A B (and consequently my Hedge) as followeth.

Ch.	Lin.	Ch.	Lin.	Ch.	Lin.
.		Station A			
0	25				
0	90	1	10		
1	05	2	30		
0	70	3	25		
1	50	5	30		
0	75	7	45		
0	25	8	12		

V. *To Protract this Observation.*

First, Out of any Scale, take 8 Chains 12 Links, and lay that distance down from A to B.

Secondly, Take 15 Links out of your Scale, and set it from A to C.

Thirdly, Take 1 Chain 20 Links, and set them from A to *b*; and from thence set .90 Links to D.

Fourthly, Take 2 Chains 30 Links, and set them from A to *c*; and from thence set 1 Chain 05 Links to E.

Fifthly, Take 3 Chains 25 Links and set them from A to *d*; and from thence set 70 Links to F.

Sixthly, Take 5 Chains 30 Links, and set them from A to *o*; and from thence set 1 Chain 50 Links to G.

Seventhly, Take 7 Chains 45 Links, and set them from A to *f*; and from thence set .75 Links to H.

Lastly, From B, at the end of 8 Chains 12 Links, set 25 Links from B to K.

Then draw the Line C D E F G H K, which shall represent the Hedge: This done, the next work will be,

VI. *To find the true* Area *or* Superficial Content *of this irregular Figure* A C D E F G H K B, *in Acres, Roods, and Perches.*

1. The Perpendicular A C is 25 Links, and the Perpendicular *b* D is .90 Links; which added together make 1 Chain .15 Links: the half whereof is 57 Links, which multiplied by 1 Chain 20 Links, the Product is .06840, for the Content of the *Trapezia* L.

2. The Perpendicular *b* D is .90 Links, and the Perpendicular *c* E is 1 Chain 05 Links; which added together make 1 Chain 95 Links; the half whereof is .97 Links: Then subtract 1 Chain 20 Links from 2 Chains 30 Links, the remainder will be 1 Chain 10 Links; which multiplied by 97 Links, the Product will be .10670 for the Content of the *Trapezia* M.

3. The Perpendicular *c* E is 1 Chain 05 Links, and the Perpendicular *d* F .70 Links, which added together make 1 Chain 75 Links: the half whereof is .87 Links: Then subtract *b c* 2 Chains 30 Links from *c d* 2 Chains 25 Links, the remainder will be .95 Links; which multiplied by .87 Links, the Product is .08265, for the Content of the *Trapezia* N.

4. The Perpendicular *d* F is 70 Links, and the Perpendicular *e* G is 1 Chain 50 Links, which added, make 2 Chains 20 Links; whose half is 1 Chain 10 Links: Then subtract *c d* 3 Chains 25 Links from 5 Chains 30 Links, the remainder is 2 Chains 05 Links; and that multiplied by 1 Chain 10 Links produceth .22550, for the Content of the *Trapezia* O.

5. The

Fig. VII.

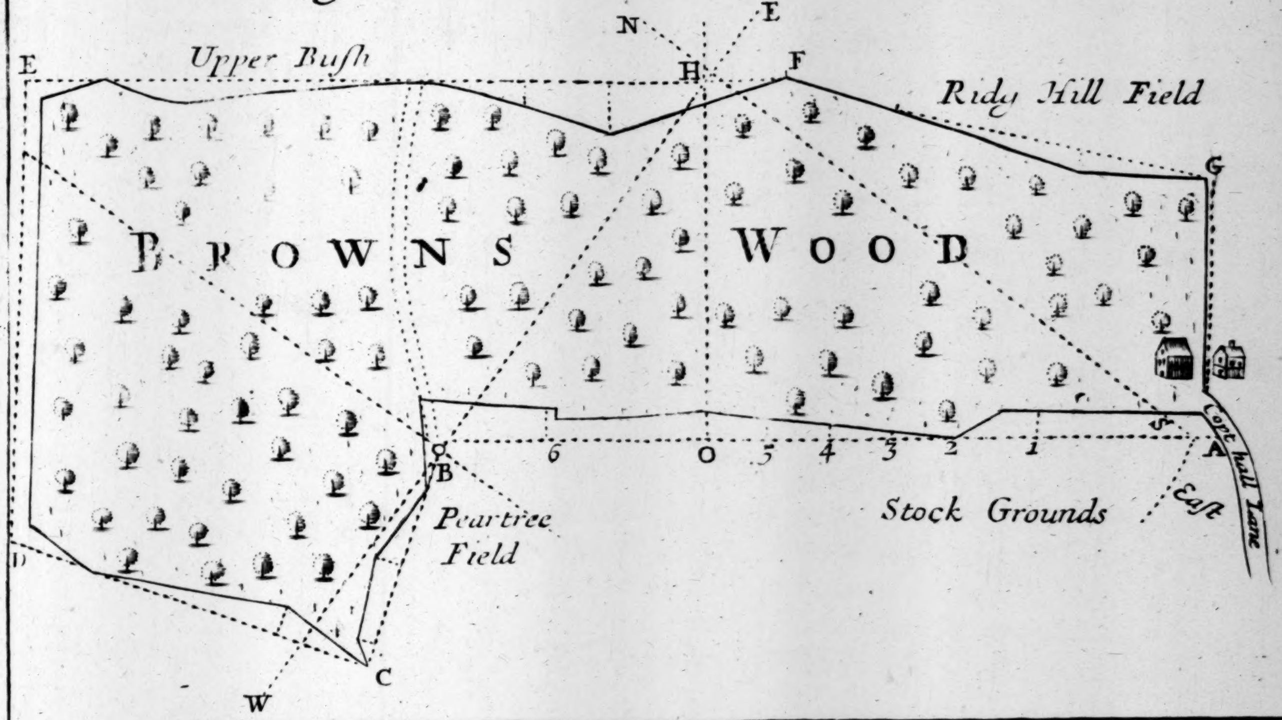


Fig. VIII.

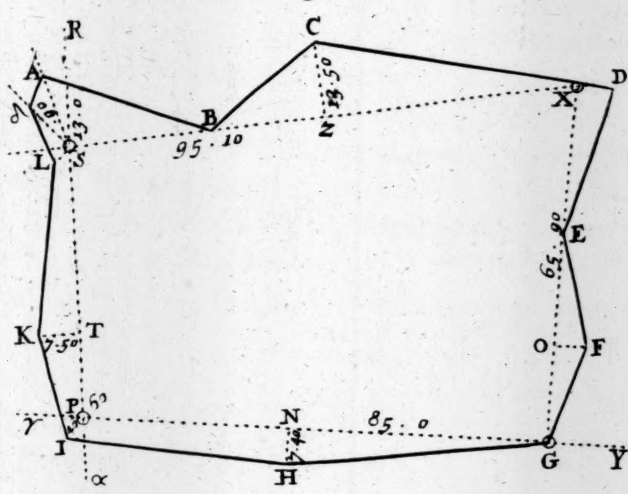


Fig. IX.

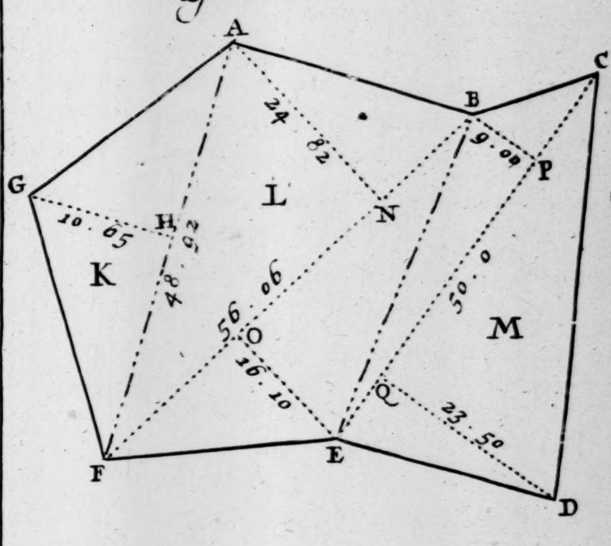
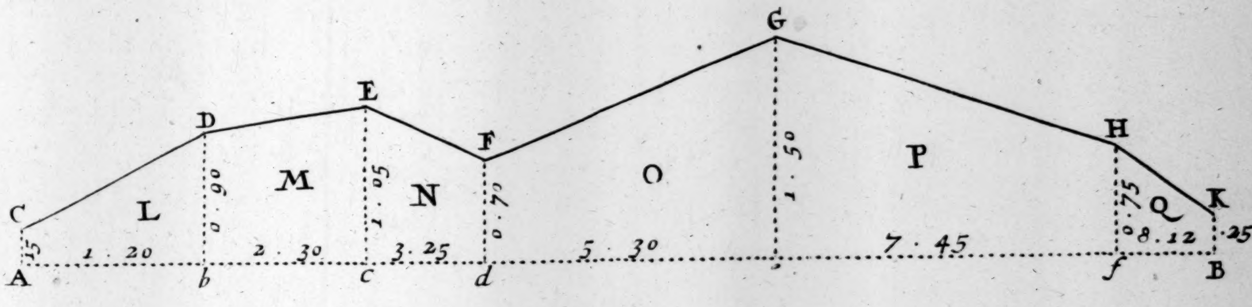


Fig. X.



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5. The Perpendicular *e* G is 1 Chain 50 Links, and the Perpendicular *f* H is .75 Links; their summ is 2 Chains 25 Links, and the half 1 Chain 12 Links: Then subtract 5 Chains 30 Links from 7 Chains 45 Links, the remainder is 2 Chains 15 Links; which multiplied by 1 Chain 12 Links, the Product .24080, is the Content of the *Trapezia* P.

6. The Perpendicular *f* H is .75 Links, and the Perpendicular B K is 25 Links, their Summ is 1 Chain; the half whereof is 50 Links. Subtract 7 Chains 45 Links from 8 Chains 12 Links, there remains .67 Links; which multiplied by .50 Links, the Product is .03350, for the Content of the *Trapezia* Q.

Add all these Products together, as here done, and the Summ of them is .75755. which reduced, is 0 Acres, 3 Rood, and 1 Perch; and so much is contained in the irregular Piece A C D E F G H K B.

L —	.06840
M —	.10670
N —	.08265
O —	.22550
P —	.24080
Q —	.03350
	.75755

And this way of Casting up these irregular Off-sets is the most exact of any other.

The End of the Second Part.

THE DOCTRINE OF RIGHT-LINED TRIANGLES, Applied to PRACTICE IN Military Architect, OR FORTIFICATION.

PART III.

CHAP. I.

Of a Fort, *or* Fortification; *and of ſeveral* Axioms *to be obſerved therein.*

FIrſt, A Fort is made to the intent that a few Men might be able to defend themſelves, and the Place, againſt a greater Number. (2.) Therefore the Place is environed with a Rampire or Wall, and a Ditch, of ſufficient height, breadth, and depth, to impeach the Aſſaults of an Enemy. (3. And becauſe the Sides thus incloſing a Fort are not of themſelves ſufficient, they have therefore Flanks to defend them; which Flanks are alſo themſelves Flanked by the Curtains or Sides. (4.) And for the better defence of each Curtain, it is requiſite that every Side of a Fort ſhould have two Flanks; and if the Curtain be very long, it may have four, ſix, or more. (5.) And ſo there will be two Flanks placed near together, the one ſcowring the Side towards the Right hand, and the other towards the Left, either Flank ſtanding Perpendicular to the Curtain that they Flank. (6.) And ſeeing the Curtains and Fronts of a Fort are eſpecially defended, therefore the greater the Flanks and the Gorge between them are, the better they are. (7.) And foraſmuch as the Front of a Bulwark needs the moſt defence, it ought ſo to be drawn, that it may be defended by Shot from as great a part of the Curtain as may be, which part of the Curtain is called the Second Flank. (8) The outward Flanking Angle ought never to exceed 150 Degrees; for, by how much the leſſer, ſo much the better it is: Neither ſhould the Outward or Diamond-point of a Bulwark be greater than 90 Degrees, nor leſſer than 60 Degrees. (9) And as the inward Flanking Angle, and the Angle of the Shoulder of the Bulwark, increaſe and decreaſe together, one exceeding the other 90 Degrees; therefore, as the inward Flanking Angle ſhould never be leſs than 15 Degrees, ſo the Angle of the Shoulder ſhould never be leſs than

than 105 Degrees. (10.) The longest Line of Defence drawn from the Angle of the Flank to the outward Angle of the Bulwark, should never exceed 720 Foot, for that it ought not to be without Musket-shot. (11.) A Regular Fort is such a Fort as consists of Equal Sides and Angles: And, (12.) Such a Fort doth enclose a greater quantity of Ground, and the Force is in all Parts alike; therefore a Regular Fort, (if the Ground or Place will admit, is better than an Irregular of the like number of Sides and Angles. (13.) And by what hath been already said, in the Eighth before-going, it is evident, that a Fort of Three Sides and Angles is of no moment, nor one of Four of any great value; but the more Sides and Angles a Fort hath, the better and stronger it is. Wherefore, (14.) If the Fixed Line of Defence be 720 Foot, or (as in the Tables following) 72.00 Rod, then may the Curtain be about 42 Rod, the Front of the Bulwark about 28 Rod, and the Flank to the Gorge as 6 is to 7, and the Angle forming the Flank about 40 Degrees.

CHAP. II.

Explaining the Terms of Art *used in* Fortificatoin, *especially of the* Parts *or* Members *of a* Fort.

I. A *Fort* is a Piece of Ground environed with a Rampire or Wall, and a Ditch, to impeach the Assaults of an Enemy. *Fig.* I.
II. A *Fortress* is a small Fort, Castle, or Sconce.
III. A *Rampire* is a Wall of Earth enclosing the Place Fortified, the Foot or Foundation whereof is (in the Figure below) noted with *a b*.
IV. A *Curtain*, O N.
V. A *Bulwark*, N F G H E.
VI. The *Front* of a Bulwark, F G, or K L.
VII. A *Flank*, N F, or O L.
VIII. The *Gorge* of a Bulwark, or the Space between two Flanks, as N E.
IX. The *Gorge-Line*, N C.
X. The *Head-Line*, C G.
XI. The *Shoulder*, F or L.
XII. The *Diamond-Point* of the Bulwark; or sometimes, the *Flanked Angle* of the Bulwark.
XIII. The *Second Flank*, O *i*.
XIV. The *Fixing-Fixed*, or *Longest Line of Defence*, O G.
XV. The *Shortest Line of Defence*, *i* G.
XVI. The *Inward Flanking Angle*, F *i* N.
XVII. The *Outward Flanking Angle*, K P G.
XVIII. The *Fausse-bray*, the Breadth whereof is noted with B C.
XIX. The *Ditch*, the Breadth whereof is noted with *d e*.
XX. The *Covert-way*, the Breadth whereof is noted with *e f*.
XXI. A *Casemate*.
XXII. The *Parapet*, *viz.* of the Rampire, Fausse-bray, and Covert-way.
XXIII. The *Walk* on the Rampire.
XXIV. The *Scarpe* inward and outward, *viz.* of the Rampire, Parapets, and Ditch.
XXV. *Palizadoes*.
XXVI. A *Bank* or *Foot-pace*.
XXVII. The *Brim* of the Ditch.
XXVIII. The *Counterscarpe*.
XXIX. A *Ravelin*.
XXX. An *Half-Moon*.
XXXI. An *Horn-work*.
XXXII. A *Trench*.
XXXIII. *Gabions*.
XXXIV. A *Breach*.
XXXV. A *Mine*.
XXXVI. A *Counter-mine*.

There

There are other *Terms* used in this Art, which will be better understood when there shall be occasion to make use of them.

Having hitherto delivered several *Definitions* and *Axioms* necessary to be known, I shall now come to apply the Doctrine of *Right-lined Plain Triangles* to Practice in this Art.

CHAP. III.

To find the Quantity of the Angles *in all Parts of a* Fort, *of any number of Sides proposed.*

BY the Thirteenth *Axiom* before-going, a Fort is to consist at least of Four Sides; and by the Eighth *Axiom*, the Flanked Angle of a Bulwark ought to be (at the least) 60 Degrees; therefore in a Regular Fort of Four Sides, the Flanked Angle of each Bulwark ought to be 60 Degrees; and therefore (by the Ninth *Axiom*) the Outward Flanking Angle (exceeding the Inward Flanking Angle by 90 Degrees) must needs be 150 Degrees.

Fig. II. In this Figure let B C be one Side of a Square, fortified with four Bulwarks, one of which let be N F G H T: And seeing the Flanked Angle of this Bulwark F G H is 60 Degrees, therefore the Half thereof, F G C, is 30 Degrees; and I G C, (being equal to D C A, namely, half the Angle of the Angle of the *Tetragon* or Square,) 45 Degrees, therefore S G F is 15 Degrees, and the Complement thereof, S F G, 75 Degrees, whereto is equal the Angle I M G, which is the half of K M G: Therefore the Outward Flanking Angle K M G is 150 Degrees, which was to be proved.

And thus seeing that in a Quadrangular Fort, the Flanked Angle is 60 *Degrees*, and the Outward Flanked Angle 150 Degrees, what these Angles will be in other Forts, consisting of more Sides than Four, we may find by help of these in manner following; for which this is the

RULE.

Subtract the Angle of the Square, 90 *Degrees, from the Angle of the* Polygon *proposed; half the Remainder add to the Flanked Angle of the Square,* (viz. 60 *Degrees*;) *so have you the Flanked Angle of the* Polygon *proposed.*—— *Also, Subtract the Half-remainder from the Flanking Angle of the Square,* (viz. 150 *Degrees*,) *and the Remainder is the Flanking Angle of the* Polygon *proposed.*

Example I. Of a *Pentagon.*		*Degr.*
The Angle at the *Perimetre* of the *Pentagon* is		108
The Angle of the Square,	Subtract	90
The Remainder		18
The Half whereof is		9
To which add the Flanked Angle of the Square		60
Gives the Flanked Angle of the *Pentagon*		69
From the Flanked Angle of the Square		150
Subtract the aforesaid Half-remainder		9
There remains the Flanked Angle of the *Pentagon*		141

Example II. Of a *Hexagon.*	*Degr.*
From the Angle of the *Hexagon*, being	120
Subtract the Angle of the Square	90
And there remains	30
The Half whereof	15
Added to the Flanked Angle of the Square	60
Gives the Flanked Angle of the *Hexagon*	75
And from the Flanked Angle of the Square	150
Subtract the foresaid Half-remainder	15
There remains the Flanked Angle of the *Hexagon*	135

And proceeding in this manner, you shall find, that the Flanked Angle will not be 90 Degrees, till you come to a Fort of Twelve Sides. And,

Now

Now the Flanked Angle of a Bulwark being given, you may thereby come to the knowledge of all the other Angles requisite to be known.

Fig. III.

		D.	M.
In the *Figure*, let B C be the side of a *Pentagon*, whose Angle at the Centre is	B A C	72	00
The half whereof is	C A D	36	00
The Complement thereof to 90 Degrees is	D C A	54	00
Now, admit the Angle at the Bulwark	F G H	69	00
The half thereof	F G C	34	30
Subtracted from S G C, equal to	D C A	54	00
Remains the inward Flanked Angle	S G F	19	30
Equal to F P N, the Complement of either	S F G	70	30
Subtracted from two Right Angles		180	00
Leaves the Angle of the Shoulder	N F G	109	30
Again, The same Angle S F G, or	I M G	70	33
Doubled, gives the outer Flanked Angle.	K M G	141	00
Lastly, From two Right Angles		180	00
Subtract half the Angle of the *Polygon*	B C A	54	00
There remains the Angle	D C G	126	00

And thus, from any Flanked Angle proposed, you may find the Quantities of every of the other Angles.

But for any *Polygon* proposed, you may more compendiously set down the Angles of the Bulwark, and all the other Angles after the form of this *Example* following: remembring, that if the *Polygon* have more than 12 Sides, you make the Angle at the Bulwark a Right-Angle.

		D.	M.
To half the Angle of the *Polygon*	B C A	54	00
Add always		15	00
The Summ is the Flanked Angle	F G H	69	00
The half whereof	F G C	34	30
Subtract from half the Angle of the *Polygon*	B C A	54	00
There remains the inward Flanking Angle	S G F	19	30
Whose Complement is	S F G	70	30
Which subtracted from two Right Angles		180	00
Leaves the Angle of the Shoulder	G F N	109	30
And the same Complement S F G, or	I M G	70	30
Doubled, is the outward Flanking Angle	K M G	141	00

For the Angle forming the Flank, namely, the Angle F C N, it may be always about 40 Degrees. And according to this Rule is the following *Table* made.

A TABLE of the Dimensions of the Angles observed in in Fortifying any regular Polygon, *from the Square, to a* Figure *of* XII. *Sides: increasing, so that the Flanked Angle thereof is a Right Angle.*

The Number of the Sides of the *POLYGONS.*		IV.		V.		VI.		VII.		VIII.		IX.		X.		XI.		XII.	
		deg.	m.	deg.	m.	deg.	m.	deg.	m	deg.	m.	deg.	m.	deg.	m.	deg.	m	deg.	m.
Angle at the Centre	B A C	90	0	72	0	60	0	51	17	45	0	40	0	36	0	32	43	30	0
Angle of the *Polygon*	B C E	90	0	108	0	120	0	128	40	135	0	140	0	144	0	147	22	150	0
Half the Angle of the *Polygon*	B C A	45	0	54	0	60	0	64	17	67	30	70	0	72	0	73	37	75	0
To which (always) add		15	0	15	0	15	0	15	0	15	0	15	0	15	0	15	0	15	0
The Flanked Angle	F G H	60	0	69	0	75	0	79	17	82	30	85	0	87	0	88	38	90	0
Half the Flanked Angle	F G C	30	0	34	30	37	30	39	38	41	15	42	30	43	30	44	19	45	0
Inward Flanking Ang. F P N, or S G F		15	0	19	30	22	30	24	38	26	15	27	30	28	30	29	19	30	0
Which added to a Right Angle		90	0	90	0	90	0	90	0	90	0	90	0	90	0	90	0	90	0
Angle of the Shoulder	N F G	105	0	109	30	112	30	114	38	116	15	117	30	118	30	119	37	120	0
Angle opposite to the Head Li.	G F C	55	0	59	30	62	30	64	38	66	15	67	30	68	30	69	43	70	0
Angle opposite to the Front	F C G	95	0	86	0	80	0	75	43	72	30	70	0	68	0	66	21	65	0
Complement of S G F, *viz.*	S F G	75	0	70	30	67	30	65	42	63	45	62	30	61	30	60	44	60	0
Outward Flanking Angle	K M G	150	0	141	0	135	0	130	42	127	30	125	0	123	0	121	21	120	0
Angle fronting the Flank	F C N	40	0	40	0	40	0	40	0	40	0	40	0	40	0	40	0	40	0

But

But if you would have the Flanked Angle of the Bulwark so to increase that for an *Octagon* it may be a Right Angle, then make the Flanked Angle two Third parts of the Angle of the *Polygon* proposed; as is done in the *Table* following: But for any *Polygon* of above Eight Sides, let the Flanked Angle be a Right Angle.

A TABLE of the Dimensions of the Angles observed in Fortifying any regular Polygon, *from the Square to a* Figure *of* VIII. *Sides, so increasing, that the Flanked Angle of the* Octagon *is a Right Angle.*

The Number of the Sides of the *POLYGONS.*		IV.		V.		VI.		VII.		VIII.	
		deg.	m	deg.	m.	deg.	m.	deg.	m.	deg.	m.
The Angle at the Centre	B A C	90	0	72	0	60	0	51	26	45	00
Half the Angle at the Centre	I A G	45	0	36	0	30	0	25	43	22	30
The Angle of the *Polygon*	B C E	90	0	108	0	120	0	128	34	135	0
The Flanked Angle	F G H	60	0	72	0	80	0	85	43	90	0
Half the Angle of the *Poylgon*	B C A	45	0	54	0	60	0	64	17	67	30
Half the Flanking Angle	F G C	30	0	36	0	40	0	42	51	45	0
The inward Flanking Angle	S G F	15	0	18	0	20	0	21	26	22	30
To which add a Right Angle		90	0	90	0	90	0	90	0	90	0
The Angle of the Shoulder	N F G	105	0	108	0	110	0	111	26	112	30
Angle opposite to the Head Line	G F C	55	0	58	0	60	0	61	26	62	30
The opposite Angle to the Front	F C G	95	0	86	0	80	0	75	41	72	30
The Complement of S G F, *viz.*	S F G	75	0	72	0	70	0	68	34	67	30
The outward Flanking Angle	K M G	50	0	144	0	140	0	137	08	135	0
The Angle forming the Flank	F C N	40	0	40	0	40	0	40	0	40	0

CHAP. IV.

Of the Quantity of the Curtains, Flanks, Fronts, Gorges, *and other* Lines *and* Sides, *in* Regular Forts *of any determined number of* Sides.

THere is no necessity that the Angles in Forts should be exactly such as are form'd and set down by the foregoing Rules, but they may be something more or less, as the place or other occasions shall require: But, first supposing them to be such, I will shew how to determine the quantity of the Sides and Lines of a Fort accordingly: Both by *Trigonometrical Calculation*, and by *Tables* also.

PROB. I.

The Length of the Curtain, and of the Front of the Bulwark given, to find what the other Sides and Lines should be.

AS in the regular *Pentagonal* Fort, *Fig.* III. and so in others, to the intent the Line of defence may be about 72 Rod, the Curtain 42, and the Front about 28; as is before noted in the 14th *Axiom*, *Chap.* I. and that the Proportion of the Flank to the Gorge be as 6 to 7: and let the Angle forming the Flank be 40 deg.

Thus then

The Curtain is	O N 420 Foot.
The Front of the Bulwark is	F G 280 Foot.
The Angle forming the Flank	F C N 40 deg.
And let the Flanked Angle be	T G H 69 deg.

Then

Then will the other Angles be found, by the first Rule of the foregoing Chapter, to be such as are expressed in the First of the two Tables; but for the Sides, we will find them by *Trigonometrical Calculation*, as followeth.

Example I. In the *Right-angled Triangle* S G F; By *Case* III. of *Right-angled Triangles*.

As *Radius*, 90 deg.	10.00000
To the Front of the Bulwark F G, 280 Foot	2.44715
So is the Sine of the Inner Flanking Angle S G F, 19 d. 30 m.	9.52350
To the Line S F, 93 d. 47 m.	1.97065

Again, By the same *Case* I.

As *Radius*, 90 deg.		10.00000
To the Front of the Bulwark F G, 280 foot,		2.44715
So Co-sine the Inward Flanking Angle, 70 d. 30 m.		9.97435
To the Line S G,	263.94 foot	
Half the Curtain S I, add	210.00	

The Summ is 473.94 for the Line I G; which doubled, is the Side of the Outward *Polygon*, or the Distance of the Diamond Points of the Bulwark K G, 947.88.

In the *Triangle* I A G, by *Case* II. of *Right-angled Triangles*.

As the Sine of half the Angle at the Centre I A G, 36 d. 0 m. Co. Ar.	0.23078
To half the Side of the Outward *Pentagon* I G, 473.94.	2.67572
So is the *Radius*, 90 d.	10.
To the Semidiametre of the Outward *Pentagon* A G, 806.31.	x2.90650

In the same *Triangle*, by the *Case* I. of *Right-angled Triangles*.

As the Sine of the Angle at the Centre I A G, 36 d. 00 m.	Co. Ar.	0.23078
Is to half the Side of the Outward *Pentagon* I G, 47396.		2.67572
So is the Co-sine of half the Angle at the Centre I A G, 54 d. 00 m.		9.90796
To the Perpendicular of the Outward *Pentagon* A I, 652.32.		x2.81446

In the *Triangle* F C G, by *Case* I. of *Oblique-angled Triangles*.

As the Sine of the Angle F C G, 86 d. 00 m.	Co. Ar.	0.00106
Is to the Front F G, 280.00.		2.44715
So is the Sine of half the Flanked Angle F G C, 59 d. 30 m.		9.93532
To the Line F C, 158.98.		x2.38353

In the same *Triangle*, and by the same *Case*.

As the Sine of the Angle F C G, 86 d. 00 m.		Co. Ar.	1.00106
Is to the Front F G, 280.00			2.44715
So is the Sine of the Angle G F C, 59 d. 30 m.			9.93532
To the Head Line C G,	241.44		3.38353
Which subtracted from A G,	806.31	the Semidiametre of the Inner *Pentagon*,	
There remains	564.87		

In the *Triangle* F C N, by *Case* III. of *Right-angled Triangles*.

As *Radius*, 90 deg.	10.00000
To the Line F C, 158.98, before found,	2.20134
So is the Sine of the Angle forming the Flank F C N, 40 d. 00 m.	9.80807
To the Flank F N, 102.19	x2.00941

The Flank F N being	102.19
Add to it the Line first found, S F	93.47
The Summ is the Difference of the *Pentagons* I O,	195.66
Which subtracted from the Perpendicular A I,	652.32
There remains	456.66

for A D, the Perpendicular of the Inner *Pentagon*.

In

In the Triangle F N C, by *Case* III. of *Right-angled Triangles.*

As the *Radius*, 90 deg.		10.00000
To the Line before found, F C, 158.98		2.20134
So is the Co-sine of the Angle forming the Flank F C N, 50 deg,		9.88425
To the Gorge-Line N O, 121.78.		$\cancel{1}2.08559$
To the Gorge-Line, N O	121.78	
Add half the Curtain D N	210.00	
The Summ is the Line D C	331.78	
Which doubled is B C	663.56	
for the Side of the Inward *Pentagon.*		

In the *Triangle* F P N, by *Case* I. of *Right-angled Triangles.*

As the Sine of the Inner Flanking Angle F P N, 16 d. 30 m.		Co. Ar. 0.47650
Is to the Flank F N, 162.19		2.00941
So is Co-sine of the Inner Flanking Angle F P N, 70 d. 30 m.		9.97435
To the Line P N	288.58	$\cancel{1}2.46026$
Which subtracted from the Curtain O N,	420.00	
The Remainder is the Second Flank O P,	131.42	

In the *Triangle* R O G, by *Case* IV. of *Right-angled Triangles.*

To the Line before found, S G,	263.94	
Add the Curtain O N	420.00	
The Summ is the Line R G	683.94	

Then,

First, As the Line R O, or I D, 195.66		Co. Ar. 7.70850
Is to the Line R G, 603.94		2.83502
So is *Radius*, 45 deg.		10.00000
To the Tangent of the Angle R O G, 74 d. 02 m.		10.54352
Secondly, As the Sine of the Angle R O G, 74 d. 02 m.		Co. Ar. 0.01709
Is to the Line R G, 683.94		2.83502
So is the *Radius*, 90 deg.		10.
To the Length of the Line of Defence, O G, 711.40		$\cancel{1}2.85211$

And in this manner the Distances D M, P M, *&c.* might be found.

Example II. In the same *Pentagonal* Fort, *Fig.* III. let the Parts be as before, namely,

The	Curtain O N	420.00 Foot.
	Front of the Bulwark F G	289.00 Foot.
	Angle forming the Flank F G N	40 Degrees.
And let the Flanked Angle of the Bulwark be F G H		72 Degrees.

Then will the other Angles be found by the Second Rule of the Chapter beforegoing, to be such as are there expressed in the latter of the two Tables: And for the Sides, we will find them as before.

In the *Triangle* S G F.

As the *Radius*, 90 deg.	10.00000
Is to the Front of the Bulwark F G, 280.00 Foot	2.44715
So is the Sine of the Inward Flanking Angle S G F, 18 d. 00 m.	9.48998
To the Line S F, 86.52 Foot	$\cancel{1}2.33713$

In the same *Triangle* S G F.

As the *Radius*, 90 deg.		10.
To the Front of the Bulwark F G, 280.00		2.44715
So is the Co-sine of the Inward Flanking Angle, S G F. 72 d. 00 m.		9.97821
To the Line S G,	266.29	$\cancel{1}2.42530$
To which add half the Curtain S I,	210.00	
The Summ is the Line I G,	476.29	
The Double whereof is	952.58, and is the Distance K G, between the two Angular Points of the Bulwarks.	

In

In the *Triangle* I A G.

As the Sine of half the *Angle* at the Centre A G, 36 d. 00 m. Co. Ar. 0.23078
To half the Side of the outward *Pentagon* I G, 476.29. 2.67787
So is *Radius* 90 d. 10.
To the Semidiametre of the outward *Pentagon* A G, 810.31. x2.90865

In the same *Triangle*.

As the Sine of half the *Angle* at the Centre I A G, 36 d. 00 m. Co. Ar. 0.23078
To half the Side of the outward *Pentagon* I G, 476.29. 2.67787
So is the Co-Sine of half the *Angle* at the Centre, I A G 54 d. 00 m. 9.90796
To the greater Perpendicular A I, 655.56 x2.81661

In the *Triangle* F C G.

As the Sine of the *Angle* F C G, 86 d. 00. Co. Ar. 0.00106
Is to the Front F G, 280.00. 2.44715
So is the Sine of half the Flanked *Angle* F G C, 36 d. 06 m. 9.76922
To the Line F C, 164.98. x2.21743

In the same *Triangle* F C G.

As the Sine of the *Angle* F C G, 86 d. 00 m. Co. Ar. 0.00106
Is to the Front F G, 280.00. 2.44715
So is the Sine of the *Angle* G F C, 58 d. 00 m. 9.92842
To the Head Line C G, 238.03 x1.37663
Which subtracted from the Semidiametre A G, 810.31
There remains 572.28, for the Semidiametre of the inner *Pentagon*.

In the *Triangle* F C N.

As *Radius* 90 d. 10.
To the Line before found, F C, 164.98 2.21743
So is the Sine of the *Angle* forming the Flank F C N, 40 d. 00 m. 9.80807
To the Flank F N, 106.05 F N, 106.05 x2.02550
To which add the Line first found S F 86.52
The summ is the distance of the *Pentagons* S N or I D 192.57
And this subtracted from the Perpendicular A I 655.56
Leaves the Perpendicular of the inner *Pentagon* A D 462.99

In the *Triangle* F N C.

As the *Radius*, 90 deg. 10.
Is to the Line last found F C, 164.98. 2.21743
So is the Co-sine of the *Angle* forming the Flank F C N, 50. d. 0 m. 9.88425
To the Gorge Line N C 126.38 x2.10168
To which add half the Curtain D N 210.00
The summ is the Line D C 336.38
Which doubled, is the side of the inward *Pentagon* B C 672.70

In the *Triangle* F P N.

As the Sine of the inward Flanking *Angle* F P N, 18 d. 00 m. Co. Ar. 0.51001
Is to the Flank F N, 106.05 2.02550
So is the Co-Sine of the inward Flanking *Angle* F P N, 72. d. 00 m. 9.97821
To the Line P N 326.39 x2.51372
Which subtracted from the Curtain O N 420.00
There remains the second Flank O P 93.67

In the *Triangle* R O G.

To the Line before found S G 266.29
Add the Curtain O N 420.00
Their summ is the Line R G 686.29

	Then,	
First,	As the Line R O, or I D, 192.57	Co. Ar. 7.71541
	Is to the Line R G, 686.29	2.83651
	So is the *Radius*, 45 d.	10.
	To the Tangent of the *Angle* R O G, 74 d. 20 m.	10.55192
Secondly,	As the Sine of this *Angle* R O G, 74 d. 20 m.	9.98356
	Is to the Line R G, 686.29.	2.83651
	So *Radius* 90 d.	10.
	To the longest Line of defence O G, 712.80	2.85295

Fig. II. *Example* III. In the Quadrangular Fort, *Fig.* II. Let the Parts be as followeth.

The	Length of the Curtain	O N	420.00 Foot.
	Front of the Bulwark	F G	280.00 Foot.
	Angle forming the Flank	F C N	40 d. 00 m.
	Flanked *Angle* of the Bulwark	F G H	60 d. 00 m.

In the *Triangle* S G F.

As *Radius*, 90 d.	10.
To the Front of the Bulwark F G 280.00	2.44715
So is the Sine of the inward Flanking *Angle* S G F, 15 d. 00 m.	9.41300
To the Line S F, 72.47.	x1.86015

In the same *Triangle* S G F.

As *Radius* 90 d.		10.
Is to the Front of the Bulwark F G, 280.00		2.44715
So is the Co-Sine of the inward Flanking *Angle* S G F, 75 d. 00 m.		9.98494
To the Line	S G 270.45	x2.43209
To which add half the Curtain	S I 210.00	
The summ is the Line	I G 480.45	
The double whereof is	960.90	

In the *Triangle* I A G.

As the Sine of half the *Angle* at the Centre I A G, 45 d. 00 m. Co. Ar.	0.15051
To half the side of the outward Square I G, 480.00	2.68165
So *Radius* 90 d.	10.
To the Semidiametre of the outward Square A G, 679.46	x2.83216

In the same *Triangle*.

As the Sine of half the *Angle* at the Centre I A G, 45 d. 00 m. Co. Ar.	0.15051
To half the side of the outward Square I G, 480.45	2.68165
So is the Co-Sine of half the *Angle* at the Centre I A G 45 d. 00 m.	9.84949
To the greater Perpendicular A I, 480. 45	x2.68165

In the *Triangle* C G F.

As the Sine of the *Angle* F C G, 95 d. 00 m. Co. Ar.	0.00166
Is to the Front F G 280.00	2.44715
So is the Sine of half the Flanked *Angle* F G C 30 d. 00 m.	9.69897
To the Line F C 140 53	x2.14778

In the same *Triangle* C G F.

As the Sine of the *Angle* F C G 95 d. 00 m.		Co. Ar. 0.00166
Is to the Front F G 280.00		2.44715
So is the Sine of the *Angle* G F C 55 d. 00 m.		9.91336
To the Head Line	C G, 230.23	x2.36217
Which taken from the greater Semidiametre	A G, 679.46	
There remains the lesser Semidiametre	A C, 449.23	

In

In the *Triangle* F C N.

As the *Radius*, 90 d.		10.
To the Line before form'd F C, 140.53		2.14778
So is the Sine of the *Angle* forming the Flank, F C N, 40 d. 00 m.		9.80807
To the Flank	F N 90.33	11.95585
To which adding the Line first found	S F 72.47	
You have the distance of the two Squares, K G and	B C 162.80	
Which subtracted from the Perpendicular A I	480.45	
There remains the Perpendicular of the inward Square	A D 317.65	

In the *Triangle* F N C

As the *Radius* 90 d.		10.
To the Line before found F C 140.53		2.14778
So is the Co-Sine of the Angle forming the Flank F C N 50. d. 00 m.		9.88425
To the Gorge-Line	N C 107.66	12.03203
To which add half the Curtain	D N 210.00	
So have you the Line	D C 317.66	
Which doubled, gives the Side of the inward Square	B C 635.32	

In the *Triangle* P F N.

As the Sine of the inward Flanking Angle F P N 15 d. 00 m.		Co. Ar. 0.58700
Is to the Flank F N 90.88		1.95585
So is the Co-Sine of the inner Flanking *Angle* F P N 75 d. 00 m.		9.98494
To the Line	P N 337.13	12.52779
Which subtracted from the Curtain	O N 420.00	
The remainder is the second Flank	O P 82.87	

In the *Triangle* R O G.

To the Line before found	S G 270.45
Add the Curtain	O N 420.00
The summ is the Line	690.45

Then

First, As the Line R O, or I D, 162.80	Co. Ar. 7.78835
Is to the Line R G 690.45	2.83913
So is the *Radius* 90 d.	10.
To the Tangent of the *Angle* R O G 76 d. 44 m.	10.62748

Secondly, As the Sine of the *Angle* R O G 76 d. 44 m.	Co. Ar. 0.01175
Is to the Line G R 690.45	2.83915
So is the *Radius* 90 d.	10.
To the fixed (or longest) Line of Defence O G 709.42	12.85090

Example IV. Let there be a *Heptagon*, or a *Figure* of Seven Sides, given to be Fortified with Bulwarks, *&c.* *Fig.* IV.

Let the Length of the Curtain be	O N 420.00 Foot.
The Front of the Bulwark	F G 280.00 Foot.
The *Angle* of the Bulwark	F G H 85 d. 43 m.

Then will the other *Angles* be according to the Second Rule, and Second Table of *Chapter* III. and for finding of the Sides and other Lines, proceed as followeth.

In the *Triangle* S G F.

As the *Radius*, 90 deg.	10.
Is to the Front of the Bulwark F G, 280.00	2.44715
So is the Sine of the Inward Flanking *Angle* S G F, 21 d. 26 m.	9.56279
To the Line S F, 102.31	12.00994

In the same *Triangle* S G F.

As the *Radius*, 90 deg.		10.
Is to the Front of the Bulwark F G, 280.00		2.44715
So is the Co sine of the Inward Flanking *Angle*, S G F, 63 d. 34 m.		9.96888
To the Line	S G, 260.63	~~1~~2.41603
To which add half the Curtain	S I, 210.00	
The Summ is the Line	I G, 470.63	
Whose Double is the Side of the Outward *Heptagon*	941.26	

In the *Triangle* I A G.

As the Sine of half the *Angle* at the Centre, I A G, 25 d. 43 m.	Co. Ar.	0.36259
Is to half the Side of the Outward *Heptagon* I G, 470.63		2.67268
So is the *Radius*, 90 deg.		10.
To the Semidiametre of the Outward *Heptagon* A G, 1084.61		~~1~~3.03527

In the same *Triangle* I A G.

As the Sine of half the *Angle* at the Centre I A G, 25 d. 43 m.	Co. Ar.	0.36259
To half the Side of the Outward *Heptagon* I G, 470.63		2.67268
So is the Co-sine of half the *Angle* at the Centre, I A G, 64 d. 17 m.		9.95470
To the greater Perpendicular A I, 977.17		~~1~~2.98997

In the *Triangle* F C G.

As the Sine of the *Angle* F C G, 75 d. 43 m.	Co. Ar.	0.01364
Is to the Front F G, 280.00		2.44715
So is half the Flanked *Angle* F G C, 42 d. 51½ m.		9.83261
To the Line F C, 196.52		~~1~~2.29340

In the same *Triangle* F C G.

As the Sine of the *Angle* F C G, 75 d. 43 m.	Co. Ar.	0.01364
Is to the Front F G, 280.00		2.44715
So is the Sine of the *Angle* G F C, 61 d. 26 m.		9.94362
To the Head-Line	G O, 253.75	~~1~~2.40441
Which taken from the Greater Semidiametre	A G, 1084.61	
There remains the Semidiametre of the Inward *Heptagon*	A C, 830.86	

In the *Triangle* F C N.

As the *Radius*, 90 deg.		10.
To the Line before found, F C, 196.52		2.29340
So is the Sine of the *Angle* forming the Flank, F C N, 40 d. 00 m.		9.80807
To the Flank	F N, 126.32	~~1~~2.10147
To which add the Line first found,	S F, 102.31	
The Summ is the Distance of the *Heptagons*	I D, 228.63	
Which subtracted from the Perpendicular	A I, 977.18	
There remains the Perpendicular of the Inward *Heptagon*,	748.55	

In the *Triangle* F N C.

As the *Radius*, 90 deg.		10.
To the Line before found, F C, 196.52		2.29340
So is the Co-sine of the *Angle* forming the Flank, F C N, 50 d. 00 m.		9.88425
To the Gorge-Line	N C, 150.54	~~1~~2.17765
To which add half the Curtain	D N, 210.00	
The Summ is the Line	D C, 360.54	
Whose Double is the Side of the Inward *Heptagon*	B C, 721.08	

In

In the *Triangle* F P N.

As the Sine of the Inward Flanking *Angle* F P N, 21 d. 26 m.		Co. Ar. 0.43721
Is to the Flank F N, 126.32		2.10147
So is the Co-sine of the Inward Flanking *Angle*, F P N, 68 d. 34 m.		9.96888
To the Line	P N, 321.78	12.50756
Which subtracted from the Curtain	O N, 420.00	
The Remainder is the Second Flank	O P, 98.22	

In the *Triangle* R O G.

To the Line before found,	S G, 260.63
Add the Curtain	O N, 420.00
The Summ is the Line	R G, 680.63

Then,

First,	As the Line R O, or I D, 228.63	Co. Ar. 7.64087
	Is to that Line R G, 680.63	2.83291
	So is the *Radius*, 90 deg.	10.
	To the *Tangent* of the *Angle* R O G, 72 d. 26 m.	10.47378
Secondly,	As the Sine of that *Angle* R O G, 72 d. 26 m.	Co. Ar. 0.02321
	Is to the Line R G, 680.63	2.83291
	So is the *Radius*, 90 deg.	10.
	To the Fixed (or Longest) Line of Defence, O G, 718.00	12.85612

And according to the Form of these Examples, the Quantities of the Sides and Lines of Forts (of any other Number of Sides, under or above XII.) may be determined.

Example V. In a *Quindecagon*, or Fort of Fifteen Equal Sides.

In which let be,

Curtain	O N, 420.00 Foot.
Front of the Bulwark	F G, 280.00 Foot.
Angle forming the Flank	F C N, 40 d. 00 m.
Flanked *Angle* of the Bulwark	F G H, 90 d. 00 m.

Then will the other *Angles* be as followeth.

		Deg.	*Min.*
The *Angle* at the Centre of the *Polygon*	B A C	25	00
Half the *Angle* at the Centre is	D A C	12	00
Whose Complement is half the *Angle* of the *Polygon*	B C A	78	00
Which doubled, is the *Angle* of the *Polygon*	B C E	156	00
And seeing the Flanked *Angle* of the Bulwark is	F G H	90	00
Half the Flanked *Angle* is	F G C	45	00
Taken from half the *Angle* of the *Polygon*	B C A	78	00
Leaves the Inward Flanking *Angle*	S G F	33	00
To which add a *Right Angle*		90	00
The Summ is the *Angle* of the Shoulder	N F G	123	00
From which take the Centre of the *Angle* forming the Flank	N F C	50	00
There rests the *Angle* opposite to the Head-Line	G F C	73	00
To which adding half the Flanked *Angle*	F G C	45	00
The Summ is		118	00
Which subtracted from two *Right Angles*		180	00
There remains the *Angle* opposite to the Front	F G C	62	00
Also the Centre of the Inward Flanking *Angle* is	S F G	57	00
Which doubled is the Outward Flanking *Angle*	K M G	114	00

Having thus set down the *Angles*, the Sides and other Lines may be found as in the foregoing Four Examples, which in this Example I purposely omit; but will (in two Tables) exhibit the Lines in a Fort of any number of Sides, from the *Tetragon*, (or Square,) to the *Dodecagon*, (or Figure of XII Sides,) according to the *Angles* found by either of the Two Rules delivered in *Chap.* III. before-going.

A TABLE of the Dimensions of any Regular Fortification, from the Tetragon, *(or Figure of* IV. *Sides,) to the* Dodecagon, *(or Figure of* XII. *Sides,) the Flanking Angle being* 15 *Degrees more than Half the Angle of the* Polygon.

The Number of the Sides of the *POLYGONS.*		IV.		V.		VI.		VII.		VIII.		IX.		X.		XI.		XII.	
		deg.	m.	deg.	m.	deg.	m.	deg.	m	deg.	m.	deg.	m.	deg.	m.	deg.	m.	deg.	m.
The Angle of the *Polygon*	BCE	90	0	108	0	120	0	128	34	135	0	140	0	144	0	147	16	150	0
Flanking Ang. of the Bulwark	FGH	60	0	69	0	75	0	79	17	82	30	85	0	87	0	88	38	90	0
The Angle of the Shoulder	NFG	105	0	109	30	112	30	114	38	116	15	117	30	118	30	119	19	120	0
The Inward Flanking Angle	SGF	15	0	19	30	22	30	24	38	26	15	27	30	28	30	29	19	30	0
The Outward Flanking Angle	KMG	150	0	141	0	135	0	130	43	127	30	125	0	123	0	121	21	120	0
The Angle fronting the Flank	FCN	40	0	40	0	40	0	40	0	40	0	40	0	40	0	40	0	40	0
		R.	100 par.	R.	100 par.	R.	100 par.	R.	100 par.	R.	100 par.	R.	100 par.	R.	100 par.	R.	100 par.	R.	100 par
The Curtain	ON	42	00	42	00	42	00	42	00	42	00	42	00	42	00	42	00	42	00
The Front of the Bulwark	FG	28	00	21	00	28	00	28	00	28	00	28	00	28	00	28	00	28	00
The Gorge-Line	NC	10	77	12	18	13	26	14	12	14	83	15	42	15	92	16	36	16	73
The Semidia. of the Inner *Pol g.*	AC	44	92	56	45	68	52	80	94	93	63	106	49	119	49	132	57	145	80
The Side of the Inner *Polygon*	BC	63	53	66	36	68	52	70	24	71	66	72	84	73	85	74	71	75	47
The Perpend. of the Inner *Polyg.*	AD	31	76	45	67	59	34	72	90	86	50	100	06	113	64	127	20	140	83
The Semid. of the Outer *Polygon*	AG	67	95	80	63	93	74	107	05	120	50	124	02	147	59	161	16	174	83
The Side of the Outer *Polygon*	KG	96	09	94	79	93	74	92	90	92	22	91	67	91	21	90	83	90	50
The Perpend. of the Outer *Polygon*	AI	48	04	65	23	81	18	96	42	111	32	125	93	140	37	154	63	168	87
The Distance of the *Polygons*	DI	16	28	19	57	21	84	23	52	24	83	25	87	26	72	27	43	28	04
The Flank	FN	9	03	10	22	11	13	11	85	12	44	12	94	13	36	13	72	14	04
The Head-Line	CG	23	02	24	18	22	22	26	11	26	87	27	53	28	10	28	59	29	03
The Shoulder from the Centre	FC	14	05	15	90	17	31	18	43	19	36	20	13	20	79	21	35	21	85
The Second Flank	OP	8	29	13	12	15	13	16	14	16	77	17	14	17	39	17	56	17	68
The longest Line of Defence	OG	70	94	71	14	71	30	71	43	71	55	71	67	71	77	71	86	71	94

A TABLE of the Dimensions of any Regular Fortification, from the Tetragon, *(or Figure of* IV. *Sides.) to the* Octogon, *(or Figure of* VIII. *Sides,) the Flanked Angle being Two third parts of the Angle of the* Polygon.

The Number of the Sides of the *POLYGONS.*		IV.		V.		VI.		VII.		VIII.	
		D.	10 par.	D.	10 par.	D.	10 par.	D.	10 par.	D.	10 par.
The Angle of the *Polygon*	BCE	90	0	108	0	120	0	128	34	135	0
The Flanked Angle of the Bulwark	FGH	60	0	72	0	80	0	85	41	90	0
The Angle of the Shoulder	NFG	105	0	108	0	100	0	111	25	112	30
The inward Flanking Angle	SGF	15	0	18	0	20	0	21	25	22	30
The outward Flanking Angle	KMG	150	0	144	0	140	0	137	08	135	0
The Angle forming the Flank	FCN	40	0	40	0	40	0	40	00	40	0
		R.	100 par.	R.	100 par.	R.	100 par.	R.	100 par.	R.	100 par.
The Curtain	ON	42	00	42	00	42	00	42	00	42	00
The Front of the Bulwark	FG	28	00	28	00	28	00	28	00	28	00
The Gorge Line	NC	10	77	12	64	14	00	15	05	15	90
The Semidiametre of the Inner *Polygon*	AC	44	92	57	23	70	00	83	06	96	43
The Side of the Inner *Polygon*	BC	63	53	67	28	70	00	72	11	73	80
The Perpendicular of the Inner *Polygon*	AD	31	76	46	30	60	57	74	86	89	09
The Semidiametre of the Outer *Polygon*	AG	67	95	81	03	94	62	108	46	112	47
The Side of the Outer *Polygon*	KG	96	09	95	26	94	62	94	13	93	74
The Perpendicular of the Outer *Polygon*	AI	48	04	65	56	81	94	97	72	113	15
The Distance of the *Polygons*	DI	16	28	19	26	21	32	22	86	24	06
The Flank	FN	9	03	10	60	11	75	12	63	13	34
The Head-line	CG	23	02	23	80	24	62	25	37	26	04
The Shoulder from the Centre	FC	14	05	16	50	18	28	19	15	20	76
The Second Flank	OP	8	29	9	36	9	72	9	82	9	79
The Longest Line of Defence	OG	70	94	71	28	71	56	71	80	72	00

Thus have you the Manner how to find the *Sides*, *Lines*, and *Angles* of any *Regular Fortification*, by *Trigonometrical* Calculation, by which the Excellency of that Doctrine doth appear. And now concerning *Irregular Fortification*, there might be proposed an infinite number of different Examples; but of *Irregular Fortification* in general, the *Axioms* set down in the First Chapter, and the Examples before given in *Regular* Forts, may be sufficient: Only observe, That the Figure proposed to be fortified being *Irregular*, it ought (the Plot thereof being taken by an *Instrument*, as is directed in *Surveying*) to be reduced to as much *Regularity* as the Place will permit, taking in and leaving out here and there a little, to make some near Equality of *Sides* and *Angles*. And if any *Angle* of your Figure be less than 90 deg. you are not to set a Bulwark at that *Angle*, but rather to make that *Angle* to be the *Flanked Angle* of a Bulwark: And for the other *Angles*, you are to fit Bulwarks so, as the standing *Angle* of the Bulwark may be answerable to the *Angle* of the *Polygon* whereon it stands, according to either of the Two Rules before-given in *Chap.* III. But my Intent here, is not to write a Treatise of *Fortification*, but to shew the Use of *Plain Triangles* in that Particular: Yet before I end, I will shew you how to delineate the *Ground-work* of a *Fort* upon Paper, and then say something concerning the *Works* that are to be raised on such a *Ground-work*.

CHAP. V.

How to delineate a Fort *upon* Paper *or* Vellom.

ADmit it were required to draw the Platform of a Fort of Six Sides or Bulwarks, according to some assigned Proportion: You must first find, as hath been already taught, the Angles, Sides, and other Lines in such a Fort, requisite to be known; which admit to be such as this following Table doth exhibit in Rods, Feet, and Tenth parts of a Foot.

	Rods.	Feet.	10 Parts.
The Semidiametre of the Outward *Hexagon*	93	7	4
The Side of the Outward *Hexagon*	93	7	4
The Head-Line, (the same,)	25	2	2
The Semidiametre of the Inward *Hexagon*	68	5	2
The Side of the Inward *Hexagon*, (the same,)	68	5	2
The Distance of the *Hexagons*	21	8	4
The Gorge-Line	13	2	6
The Flank	11	1	3
The Second Flank	15	1	3
The Fixing, or Longest Line of Defence	71	3	0
The Curtain	42	0	0
The Distance from the Centre of the Bulwark to the Shoulder	17	3	1
The Front of the Bulwark	28	0	0
The Angle at the Bulwark let be	75 Degrees.		

Being thus prepared, you may delineate the Fort as followeth.

1. From a Diagonal Scale take in your Compasses the Semidiametre of the Outward *Hexagon*, 93 Rod, 7 Foot, and 4 Tenths of a Foot, (or 93 Rod, 74 *Centesms* of a Rod:) Then assuming the Point A upon your Paper for the Centre of the Fort, upon A, with the Distance 93.74, describe a Circle; and (because the Side of a *Hexagon* is equal to the Semidiametre,) set the same Measure, 93.74, from G to K; so is G the Diamond-Point of one Bulwark, and K of the other: And draw the Lines A G and A K. *Fig.* V.

2. Take the Semidiametre of the Inward *Hexagon*, 68.52, and set the same from A to B and C; so C and B are the Centres of the two Bulwarks; and drawing the Line B C, set down the Gorge-Line, 13.26, from B to O, and from C to N; the Residue of which Line, *viz.* O N, is the Curtain, to which, upon the Points O and N, raise the Perpendiculars N F and O L, for the Flanks, which must be set off according to their Lengths, *viz.* 11.13 Rods. Or otherwise, Set off in the Curtain from

from O to P, and from N to Q, 15.13 Rods for the second Flanks; and drawing the shortest Lines of Defence, F G and Q K, they intersect the Perpendiculars raised for the first Flanks, in the Points L and F; so is N F the Flank, and F G the Front. And in this manner you must proceed with the other Sides of the Fort.

Otherwise,

Having drawn the Line K G, set down in the same the Side of the Outward *Hexagon* 95.74, from K to G, as before, which is the Distance of the Angular Points or Heads of the Bulwarks: Then to the Right Line K G, and to the Points in the same K and G, describe the Angles B K G, and C G K, here in this Example, each 60 Degrees; and on the Lines K B and G C, set off from K and G 25.22 for the Head-Lines, ending at B and C, which Points B and C are the Centres of the two Bulwarks; then drawing the Line B C, proceed as before.

Otherwise,

Let K and G be the Angular Points of the Bulwarks: Draw the Line K G, and on the Points K and G describe the Angles A K G and A G K, each in this Example 60 Degrees; and set off from K to B, and from G to C, the Head-Lines 25.22, drawing the Line B C, as before. Then to the Line B C, and to the Point in the same C, describe the Angle F C N, of 40 Degrees; also to the Line G A, and to the Point in the same G, describe half the Flanked Angle F G C, which is in this Example 37 deg. 30 min, and at the Concourse of these Lines C F, and G F, *viz.* at F, is the Shoulder of half the Bulwark; from which letting a Perpendicular fall to the Curtain F N, that Line F N is the Flank, N C the Gorge-Line, N O the Curtain, F G the Front, *&c.* And thus are the most essential Parts of this Fort described three several ways.

I should now proceed to the setting out of this or any other Fort upon the Ground; but for that I must refer you to the foregoing Tractate of *Surveying of Land.*

CHAP. VI.

Of the Works without the Fort, the Rampire, Parapets, *&c.*

IT is to be understood, that that which you have drawn by the Directions of the last *Chapter* in *Fig.* V. namely, the Lines K L, L O, O N, N F, F G, G H, and H T, is the outer Edge of the Rampire; which Rampire may be 7 Rods, or somewhat more or less, as occasion requires; but in a Fort of 12 Sides or more, it may be 10 Rod thick; and in a Fort of Four Bulwarks, it being of less importance, it may be but 5 Rod; and in small Sconces much less: This thickness is represented in *Fig.* I. by D V; so that the Line drawn by V, doth represent the inward Side of the Rampire, being in the Curtain, Flank, and Front, every where parallel to the outside of the Rampire before described; so that sometimes the Bulwarks are quite filled up, and in some cases it is necessary they should be so, because Assaults are commonly made against them: but here we suppose the Middle parts to be empty.

Next, if you make a Walk or *Fausse-Bray*, then from the outer Edge of the Rampire before-described, measure 2 Rods for the Breadth thereof; and 2 Rods more for the Thickness of the *Parapet* of the *Fausse-Bray*; which Spaces are here represented by D P and P Q.

Next without this *Parapet*, from the Foot of it, to the Side of the Ditch may be left half a Rod to strengthen the Foot of the *Parapet*.

All these Parts (or Members) are between the Rampire and the Ditch.

The Port or Ports are best to be made in the Middle of the Curtains, and to be placed as low as may be, and a Wooden Bridge, with Gates and Draw-Bridges over the Ditch in several places.

Then set out the Breadth of the Ditch, which may be 12 Rods, more or less, as occasion requires: Then from the Front of the Bulwark F G, and from the angular Point thereof G, raise the Perpendicular G S; and being the *Fausse-Bray*, with the *Parapet*, is 4 Rod, and the Ditch 12 Rod Broad, therefore take 16 Rod from your Scale,

Fig. I.

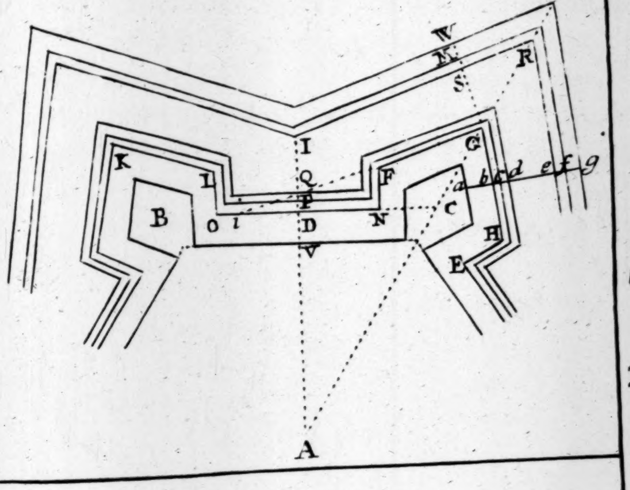


Fig. II.

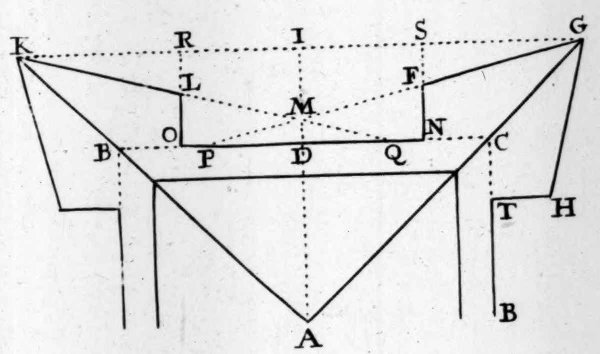


Fig. III.

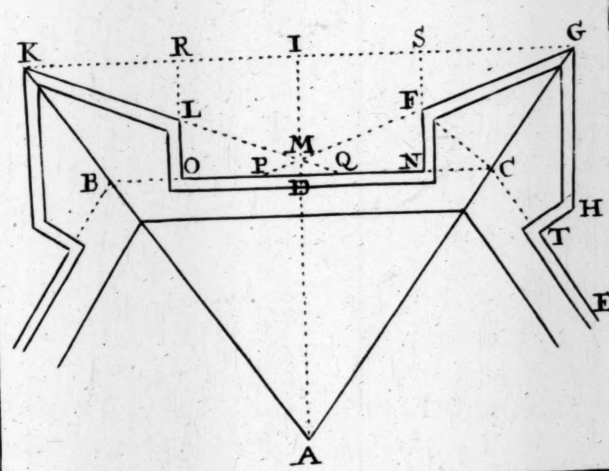


Fig. IV.

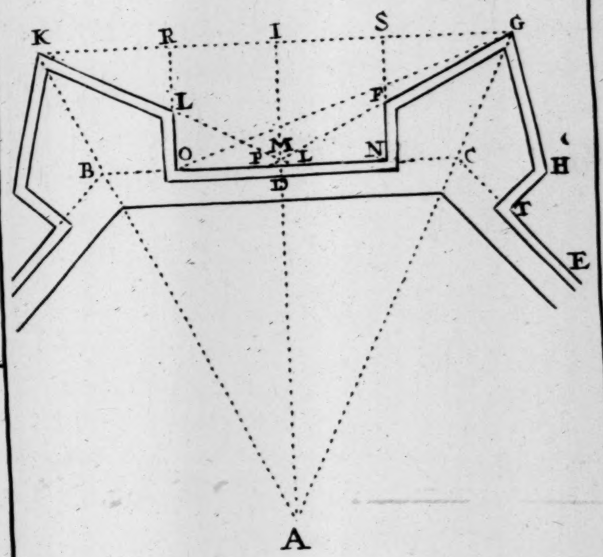
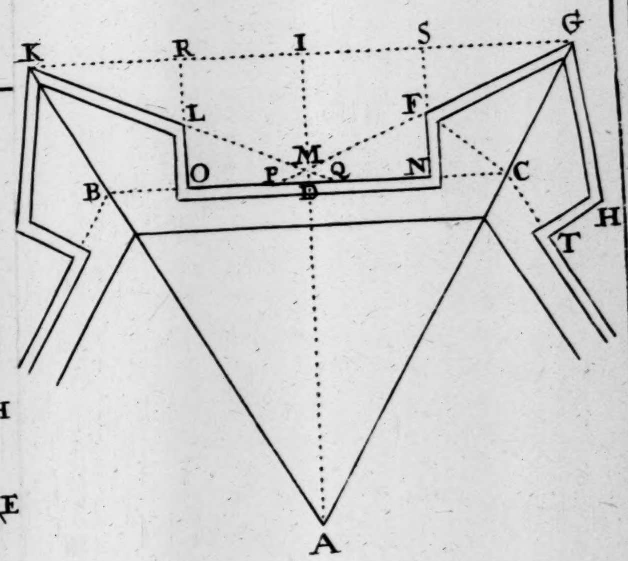
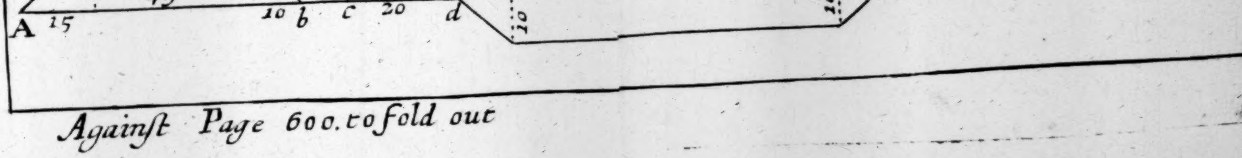


Fig. V.



The Section Fig. VI. or Profile.



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Scale, and set them from G to S, and by the Point S, draw the Line R S I, parallel to the Front of the Bulwark G F.

Next without the Ditch must be the *Coridor*, or *Covertway* of the *Counterscarp*, whose Breadth from the outside of the Ditch, may be two Rods, or thereabouts, represented by the Space S M: And without that Covert-way must be an *Argin* (or *Parapet*) 5 or 6 Rod Broad represented by M W.

CHAP. VII.

Of the Height of the Rampire *and* Parapet, *and of the Depth of the* Ditch.

THE *Ichnography* or *Ground Plot* of the Fort being drawn upon Paper or Velom, and from thence the *Rampire*, *Fausse-Bray*, *Parapet*, *Ditch*, *Covert-way*, and *Counterscarp*, as in *Figure* I. I come now to speak of the Height of them. And,

1. The *Rampire* and *Parapets* are raised of Earth, taken out of the Ditch; and touching the Form of the Works, in Height, Depth, and Scarpings, that it may be the better conceived, draw a Line, as *a b c d e f g*, cross the Front of the Bulwark, Ditch, Counterscarp, *&c.* at Right Angles; upon which Line we may represent the Breadth, Height, Depth, and Scarpings of all the Works; which, that it may be the more sensible, I here draw a longer Line apart, as in *Figure* VI. A *b c d e f* G, and on this Line set down the Breadth of the Rampire from A to *b*, 70 Foot; the Breadth of the Fausse bray, *b c*, 20 Foot; the Breadth of the Parapet thereof, *c d*, 20 Foot; leaving 5 or 6 Foot without it, for the Brow of the Ditch, and from thence set off the Breadth of the Ditch to *e*, 120 Foot; and without that the Breadth of the *Argin* or *Parapet* thereof, F G, 60 Foot: And thus you have expressed in this Line A G the Breadth of all the Works to be made.

2. Between the Points A and *b* the Rampire is to be raised, which in Forts of Four Sides may be but 12 Foot, but in a Fort of 12 Sides, or more, 18 or 20 Foot. In this Example it is made 15 Foot high.

The Rampire is to be raised on every side Scarping; *viz.* on the Outside, for every 2 Foot that it riseth, it may scarp 1; but in this Example, for every 3 that it riseth, it scarps 2 Foot; so that the top of it being 15 Foot, it scarps 10 Foot: But the Inward Side of the Rampire next the Fort scarpes more, *viz.* for every Foot that it riseth, it scarps 1 Foot; and being raised to its full height of 15 Foot, it scarps also 15 Foot: And so, though the Bottom of the Rampire be 70 Foot, yet the upper Superficies of it is but 45 Foot broad.

3. Upon the Outside of the upper Superficies of the Rampire is raised a *Parapet*, sometimes 15, sometimes 24 Foot broad; this is made to 10 Foot broad below, and on the Inward Side 6 Foot high, with a Step or Foot-pace 3 Foot broad, but outwardly not above 4 Foot high. In like sort is raised the *Parapet* of the *Fausse-bray*, and also that of the Covert-way without the Ditch, only the Outside of the Covert-way is scarping about 60 Foot, till it be even with the Champion-ground about it.

4. Touching the Ditch, it is in this Example 120 Foot broad, and 10 Foot deep, either Side of it also scarping 10 Foot; all which doth sufficiently appear in *Fig.* VI. which drawn as here you see, is called the *Section*, or *Profile*.

The End of the Third Part, and of the Sixth Book.

CURSUS
MATHEMATICUS.

Book VII.

OF
NAVIGATION.

In Four Parts.

Containing

I. An Introduction to that *Art*; with the Description and Use of such INSTUMENTS, both for *Observation* and *Operation*, as are of daily Use at Sea.

II. and III. The Doctrine of *Right-Lined Triangles*, applied to Practice, both in PLAIN, and in MERCATOR's Sailing.

IV. The Doctrine of *Spherical Triangles*, applied to Practice in *Circular Sailing*; or, *Sailing* according to the ARCH OF A GREAT CIRCLE: And in the *Solution* of such GEOGRAPHICAL and ASTRONOMICAL *Problems* as are of frequent Use in NAVIGATION.

All which

THREE WAYS of SAILING

Are *Arithmetically*, *Geometrically*, and *Instrumentally* Performed.

ALSO

A Large CONNECTION of such RULES and TABLES,

As are of continual Use in that Art.

By *WILLIAM LEYBOURN*, Philomat.

LONDON,

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OF NAVIGATION.

PART I.

THE Proœme.

Of the Antiquity and Progress of it.

THE *first* Invention *of this most excellent* Art *can be ascribed to no other than* GOD *himself, who first taught the* Hebrews, *his chosen People, (and not the* Ægyptians *and* Phænicians, *as some have falsly imagined.) For we read in* Genesis, *that* Noah, *according to* God's Precept, *made an* Ark *for the preservation of himself, and other living Creatures from the* Deluge: *for before this we do not read of any Skill in* Navigation: *And of this we have many Reasons and Conjectures given by Ancient Writers.* 1. *Because in those times there was greater need of* Cities *than* Ships; *because* Cities *are not made for* Ships, *but* Ships *for the Trade or Defence of* Cities. 2. *Because, in those days, little Commodity could be reaped from other Countries, they lying then rude and uninhabited.* 3. *Some would have this to be a reason, why God revealed not this to the* Old Worldlings; *because, being ready to perish in the* Flood, *no man might have means to escape, which doubtless they would have attempted, had* Navigation (*or the use of* Boats *or* Ships) *been known. From what hath been said it is probable that the knowledge of* Ships (*and consequently of* Navigation) *was discovered to* Noah *at the time of the* Deluge; *whose* Ark *afterwards resting upon the Mountains of* Ararat, *gave a Precedent to other Nations, near bordering, in what nature* Ships *were to be formed. From whence it came to pass, that the first to whom this Skill was derived, next to the* Hebrews, *were the* Tyrians *and* Phænicians; *Nations, as well for the commodity of the* Place, *as other Inducements, inclining to* Navigation*: For* Tyre *being a principal* Mart Town *of* Phænicia, *bordering upon the Sea, and this knowledge being derived from them to other Nations, might give occasion to* Stratus *and* Strabo *to conjecture that they were the first Inventers of it. From the* Phænicians *it was derived to the* Ægyptians, *though but in a rude and unpolished manner, as may appear by* Pliny, *who testifies, that they began to Sail in a certain* Vessel *called* Ratis, (*which now signifies a* Ship, *but was then) made only of* Beams *joyned together, in which they are reported to have passed the* Mediterranean *Sea. From the* Ægyptians *it came unto the* Grecians, *and one* Danaus *of that Country made a Ship of a more ample form than formerly, for which he was celebrated by the* Grecians *as the first Inventer.* Strabo *gives the Invention of it to* Minos, *others (as* Diodorus Siculus) *to* Neptune, *for which he was afterwards translated into the number of the Gods. But this is certain, that amongst the* Grecians, *the* Cretensians *were the first that excelled in this faculty. Others ascribe the*

building of Ships *to* Dedalus, *a rare Woork-man in* Mechanical *Occupations. From the* Grecians *it was afterwards communicated to the* Italians, *amongst whom, the* Genevensians *and* Venetians *most excelled. For the* Venetians *Skill in this matter, we read of no other argument then their great* Riches, *and Magnificent* Power, *especially by Sea, which continues so to this day. After these arose the* Portugals, *who, under the conduct and direction of* Columbus, *an* Italian, *first discovered* America; *which gave example to other* Nations *to adventure farther: Amongst which no Nation hath waded farther than the* English; *who, under* Drake *and* Candish, *have surrounded the World, and left an eternal Trophie of their immortal fame to all posterity. And to conclude, I will not let the* Hollanders, Flemming, *and* Zelanders, *pass without their just due in this particular; who, by their extraordinary Power at Sea, have kept (in despight of the Usurping* Spaniards) *these* Provinces, *and increased the* Riches *of them to far greater abundance than they were when they began their* Wars. *And thus much may suffice for the Authors and first Inventers of NAVIGATION.*

CHAP. I.

Of the Art of Navigation *in general.*

THE Care and Skill of a Perfect *Sea-man*, is to guide the Ship at Sea to any place that shall be desired; which cannot be done, unless he be able to find out in what place the Ship is at any time: So that the Practick Part of *Navigation* is principally grounded upon the knowledge of these Four things. 1. The *Longitude*. 2. The *Latitude*. 3. The *Course*. 4. The *Distance*.

SECT. I. *Of the* Longitude.

TOuching the *Longitude*; although it may be found by the other Three, yet there hath not hitherto been discovered any general Rule, true and practicable at Sea, whereby the *Longitude* of Places may immediately and ordinarily be found of themselves, which if they could, it would be the *Master-piece of Nautical Science*; and the discovery whereof hath set on work the Wits and Inventions of many Men.—— Some have laboured to find the reason thereof by the Variation of the *Magnetical Needle*; supposing certain Poles or Points unto which the ends of the *Needle* doth in all Places directly respect. But besides that, the *Meridian* is difficult to be obtained with sufficient preciseness; especially at Sea, where the chief Use of *Longitude* is: and the conceit is only imaginary, without the warrant of any Natural Principle.— Some considering the swiftness of the Motion of the *Moon*, (which is every day about 13 Degrees,) have supposed, that either by the true Place of the *Moon*, to be observed by exact *Instruments*, or else by the moment of the *Moon's* coming into the *Meridian*, the *Longitude* might be obtained: But neither the true Motion of the *Moon* is so exactly known, nor Observation at Sea can be so precisely made, that any certain truth, in so subtile a business, may be argued thereby. —— Some have thought to observe the *Longitude* by Artificial Motions of long continuance; but not without great error, and hallucination. — Some by Sand-Glasses or Water-Glasses, but both obnoxious to divers alterations and temperatures of the Air and Clime wherein they are; especially those of Sand, that of Water being more probable, especially if the Liquor be some *Chimical Spirit*, which will neither freese nor decay. These are the principal ways of keeping an Account of the *Time* as yet we know; and any, or some of them, which shall be found (by experience) most certain must be embraced; till it shall please God to open a more natural and proper way for the discovery of *Longitude*

SECT.

SECT. II. *To find the* Latitude *of the Place where the Ship is.*

THE *Latitude* of the Place wherein the Ship is, may be certainly found by the *Meridian Altitude* of the *Sun*, or of a known *Star*; or by the *Amplitude* of the *Sun*, or a known *Star*, at their Rising or Setting; as also by the *Pole Star*, &c. And divers such ways you shall find in several places of this *Book*, especially among the *Astronomical Problems* hereafter following.

SECT. III. *Of a Ship's Course.*

THE Course or Line by which the Ship must go. Now, the Course of a Ship upon the Sea, depends upon the Winds, and the designation of these upon the certain knowledge of one principal Wind; which (considering the condition and situation of the whole Sphere) ought in nature to be *North* or *South*: the *North* to us on the *North* side of the *Equinoctial*, the *South* to those on the other side of the Line: And in making this Observation, Men were to intend themselves towards one or other certain fixed part of the *Horizon*; and therefore, to one of these.

In the *Southern Hemisphere* there is not found any *Star* so notable, and of so near distance to the Pole, as to make any precise direction of that Wind; but in the *Northern Hemisphere* we have One of the Second Magnitude in the Tail of the lesser Bear, making so small, and insensible a Circle about the Pole, that it cometh all to one, as if it were the Pole it self.

This *Star* pointed out the *North*-Wind to the *Mariners* of old; and was therefore by them called the *Lead*, or *Load Star*; but this could be only in the Night season, and not always then neither: But it is now more constantly and surely shewed by the *Needle* touched with the *Magnet*, which is therefore now called the *Lead*, or *Load-Stone*, for the same reason of the Leading or Directing their Course to the *North* and *South* Parts of the Earth; not in all Parts directly, because in following the constitution of the *Great Magnet* of the whole Earth, it must needs be here and there led aside towards *East* or *West*, by the unequal temper of the *Terrestrial Globe*, consisting more of Earth than Water in some places, and more of Water than of Earth in others.

This Deviation of the *Needle* is called by the *Mariners*, the *North Easting* or *North-Westing* of the *Needle*, as it falls to be; but more Artificially, it is called the *Variation of the Compass*; and although it pretend uncertainty, yet it proveth to be one of the greatest helps that Sea-men have.

The *North* and *South* Winds being thus assured by the Motion of the *Needle*; the *Mariner* supposeth his Ship to be (as it always is) upon some *Horizon* or other; the Centre whereof is the Place of the Ship, represented by the Centre of the *Compass*, the Diametre whereof we will suppose to be the Line of *North* and *South*, which being crossed by another Line at Right Angles, sheweth the *East* and *West*; and so they have the *Four Cardinal Winds*: Again, cross these, and they have the *Eight Whole Winds*, as they call them: Another division of these make *Eight* more, which they call *Half Winds*: A third division make 16, which they call *Quarter* Winds: So that in all there are 32, which they call *Points* of the *Compass*. Thus, the *Four Cardinal Winds*, *North*, *South*, *East*, *West*, are called *Cardinal Points*; and the other intermediate *Points* are called *Rumbs*.

SECT. IV. *To find the Distance of the Ship's Way to the Place assigned.*

FOR the Distance: The finding of the Distance of a Ship's Way to any Place from which she hath departed, is the principal thing in the Practick Part of *Navigation*, which (if the *Longitude* could be easily and accurately found) would be very easie; but as hath been before delivered, that being not only intricate (or rather impossible) at all times to be put in Practice, especially at Sea, where there is most need thereof, we must content our selves with such ways as we may best manage: And this is most commonly done by a little Log fastned to a Line, and let down by the Ships side into the Water, which *Mariners* call the *Log-Line*.

SECT. V. *Of the Division of the* Log-line, *and how thereby to reckon the Way of the Ship.*

BY the quantity of Line that the *Log* ſhall draw out of the Ship in ſome certain quantity of Time, is uſually reckoned the Diſtance that the Ship hath run in that Time, or may run for ſome ſmall portion of Time after: And although this be not an Infallible Rule, yet doth it ſtand the Mariner many times in good ſtead.

The Way of finding the Diſtance run, is grounded upon this Opinion, That 5 of our *Engliſh* Statute Feet do make a Pace, and that 1000 of ſuch Paces do make a Mile, and 60 ſuch Miles do make a Degree upon the Earth, (anſwering to a Degree in the Heavens;) and according to this, a Degree ſhould contain 300000 Feet: But this Error hath been long ſince detected by my loving Friend and Country-man Mr. *Richard Norwood*, who by the Experiments of others, as well as of his own, found it to contain a greater number of Feet. The Meaſure of a Degree aſcertained to us by his Experiment is 367200 of our *Engliſh* Feet; but in reſpect to the Rotundity of the Number, and becauſe it is ſafer to reckon with the leaſt, rather than too much, he doth ſuppoſe a Degree to contain only 360000 *Engliſh* Feet: And retaining ſtill the ſame Diviſion of a Degree into 60 Miles, or 20 Leagues, a Mile will contain 6000 Feet.

Now ſuppoſing the time of the running out of the *Log-line* to be meaſured by a Half-minute Glaſs; if you obſerve how many Foot ſhe runs in half a Minute, you may thereby find out her Way for an Hour, 4 Hours, or any other Time. As,

Admit that 50 Foot of the *Log-line* ſhould run out in half a Minute, or 30 Seconds of Time; it is then apparent, that the Ship runs a Mile an Hour, 100 Feet being the 60th part of a Mile: And therefore,

As 1 Minute, is to 60 Minutes;
So is 100 Feet, to 6000 Feet.
Or,
As 1 Minute, is to 60;
So is 200 Feet, to 12000 Feet or Miles.

Upon this Ground, If at about half a ſcore Fathom, or more, from the *Log*, you make a Mark or Knot, and beginning from thence, meaſure out 50 Foot, and there make a Mark, and 50 Foot farther 2 Knots, and 50 Foot farther 3 Knots, and ſo proceeding, look how many Knots are run out in half a Minute, ſo many Miles doth the Ship run in an Hours time; and every 5 Foot more beſides the Knots, is the tenth part of a Mile: As, if there were run out, in half a Minute, 6 Knots and 45 Foot, the Ship's Way is, after that rate, 6 Miles and $\frac{9}{10}$ of a Mile in an Hour, *&c.*

SECT. VI. *Of Currents, how to diſcover where they are, which way they ſet, and their Rate of Drift or Driving.*

WHen you have a ſmooth Sea, and not much Wind, heave out the Boat, and in her three or four Aſſiſtants, with a Log-line, Compaſs, a Half-minute Glaſs, and a Warp or Line of about 100 Fathom long: To the end of your Warp faſten a Triangular piece of Board, * and at one of the Angles faſten a Weight of Lead to ſink it. When you are off from the Ship, caſt over your Board, (or other Veſſel,) and let it ſink at leaſt 60 or 100 Fathom, or more, if you have Line enough; then belaying the Line faſt about the Stern, it will bring her up, and make her ride as if at an Anchor.

* *A Kettle, or other hollow Veſſel, tied to the Warp, may ſerve.*

Then caſt over your Log, turn up the Glaſs, and as you veer out the Log-line, ſet the Drift of the Log with your Compaſs; ſo ſhall you know whether there be any Current or not; and if any, how it ſets; and the Rate of Drift or Driving.

But you muſt remember, always, to add to the Drift, (if the Line ſhe ride by be 60 Fathom, one third part; if it be 80 Fathom, one fourth part; if 100 Fathom, one fifth part; and ſo more or leſs, according to the length of your Warp or Line,) more for the Drift of the Boat: For though ſhe ſeem to ride (as at Anchor,) or lie ſtill, yet it is found by Experience, that ſhe drives in the mean time. And note,

That

That the heavier the Board and Weight is, that the Boat is to be rid by, the less will her Drift be.

Some use to judge of Currents by Rippling of the Water, and driving of Froth along the Shore, *&c.* But these are great Uncertainties, and not at all to be relied upon; and if the foregoing Way be not so exact as might be wished, yet it is found agreeable with Experience, and therefore ought to be embraced, till by farther Experience a better way be found out.

SECT. VII. *Of Lee-way.*

FOr the better judging of a Ship's Lee-way, always when you are by a Wind, and have Land in sight just on Head, take notice, as you keep the Ship steered on the Point the Land bore on, how she slides away to Lee-ward, and the Land appears more and more to Wind-ward; for by such kind of Observations, taking notice of the Sail abroad, Stress of Wind, Ship's Run, and Growth of the Sea, the Judgment may be so strengthned, that you shall rarely fail of giving a very near Allowance.

But if the Land be not right on Head, yet, by taking notice what Point it was on at first, and how it Weathers in keeping the same Course, you may thereby attain to the same advantage.

CHAP. II.

Of Instruments *appertaining to* Navigation, *both for* Observation *and* Operation; *their* Description *and* Use.

THe Principal Instruments appertaining to *Navigation*, (and all, or the most of them a Navigator cannot be well without, besides *Books*, *Maps*, *Sea-Plats*, *Plain* and *Mercator's Charts*, *Pens*, *Ink*, *Paper*, *Slate*, *Scales* and *Compasses*, are,

I. A *Plain Compass.*
II. An *Azimuth Compass.*
III. An *Universal Ring-Dial.*
IV. A *Cross-Staff*, or *Fore-Staff.*
V. A *Quadrant*, or *Back-Staff.*
VI. A *Nocturnal.*

The Description and Use of most of which follows.

SECT. I. *Of the Plain Compass.*

THE Plain Compass is no other than a Circle divided into 32 equal Parts; the Four Pricipal are the *North*, *South*, *East*, and *West*: On the North Point always there is a *Flower-de-lis*; and these Four are called the Four *Cardinal Points*, *Winds*, or *Rumbs*: The middle Point between any of these *Cardinal* ones are called *Half-Points*, *Winds*, or *Rumbs*, as are the *North-East*, *South-West*, *North-West*, and *South-East*: The other Eight are denominated as you see in *Fig.* I. and also in the two following Tables. *Fig.* I.

Points	*Between the North and East.*	*Between the North and West.*	*Between the South and East.*	*Between the South and West.*
	North	North	South	South
I	North by East	North by West	South by East	South by West
II	North North East	North North West	South South East	South South West
III	North E. by North	North W. by North	South E. by South	South W. by South
IV	North-East	North West	South East	South West
V	North East by East	North W. by West	South East by East	South W. by West
VI	East North East	West North West	East South East	West South West
VII	East by North	West by North	East by South	West by South
VIII	East.	West	East	West

And for ease in Counting, I have here inserted

A Table shewing the Angles which every Rumb or Point of the Compass make with the Meridian.

North	South	D.	M.	South	North	Points.
		02	49			
		05	38			
		08	26			
N *by* E	S *by* E	11	15	S *by* W	N *by* W	1
		14	04			
		16	53			
		19	41			
NNE	SSE	22	30	SSW	NNW	2
		25	19			
		28	08			
		30	36			
N E *by* N	S E *by* S	33	45	S W *by* S	N W *by* N	3
		36	34			
		39	23			
		42	11			
NE	SE	45	00	SW	NW	4
		47	49			
		50	37			
		53	26			
N E *by* E	S E *by* E	56	15	S W *by* W	N W *by* W	5
		59	04			
		61	52			
		64	41			
ENE	ESE	67	30	WSW	WNW	6
		70	19			
		73	07			
		75	56			
E *by* N	E *by* S	78	45	W *by* S	W *by* N	7
		81	34			
		84	22			
		87	11			
East	East	90	00	West	West	8

Now

Now to fit this Compaſs for Uſe at Sea, there are placed under the Card two Wyres, touched with a Load-ſtone, and paſted or glewed, ſo that the Ends of both the Wyres, being bended, meet together at both Ends, which Ends are placed directly under the North and South Points of the Card; and in the Centre of the Card is placed a Braſs Cap or Socket, which is to make the Card hang upon a Pin perpendicularly erected from the Centre of the Bottom of the Box; and a Glaſs over the Card, to prevent it and the Wyres from Wind and Wet.

This Box, with the Card and Wyres in it, is to be hanged in two Circles or Hoops of Braſs, and thoſe put into another Box; ſo that the innermoſt Box, and conſequently the Card, may hang Horizontally which way ſoever the Ship moveth. This Compaſs thus fitted the *Flower-de-luce* always hath reſpect to the North part of the Heavens, and conſequently all the reſt to the reſpective Points as they are denominated upon the Card; but not ſo directly, at all times, and in all places, but there is a Deflection or Deviation from the true Coaſt, which Mariners call the *Variation* of the Compaſs; of which we have already ſaid ſomething, and ſhall more hereafter.

SECT. II. *Of the* Azimuth *Compaſs.*

UPon the top of the Box wherein the Fly and Needle is faſtned, there is a broad Circle of Braſs, one half of the Limb wherof is divided into 90 deg. numbred from the middle thereof both ways by 10, 20, 30, *&c.* to 45 deg. and theſe Degrees again ſubdivided by Diagonals into 5, 10, or 15 min And the Diviſions of theſe Degrees and Minutes are drawn from the oppoſite part of the Limb whereon the *Index* moveth. Upon the *Index* is erected a Sight, to be let down or raiſed up perpendicularly at pleaſure; alſo, from the top of this Sight, down to the middle of the *Index*, is faſtned a String, to caſt its Shadow upon the middle Line of the *Index*. *Fig.* II.

This broad Circle of Braſs is croſſed at Right Angles with two Strings, and from the termination of thoſe Strings are drawn four ſmall black Lines down the Sides, on the inſide of the Box, for rectifying the Inſtrument in time of Obſervation.

This Compaſs being fitted in manner as aforeſaid, is hung in a ſtrong Braſs Ring, and thoſe alſo faſtned into a ſquare Wainſcot Box, fitted for that purpoſe. The Figure of this Compaſs, fitted as aforeſaid, in its Box, you may ſee in *Figuae* II.

The Uſe of the Azimuth *Compaſs.*

You muſt firſt rectifie the Braſs Limb, by the Needle and Fly within the Box; then if the Obſervation be in the {Forenoon / Afternoon} put the Centre of the *Index* upon the {Weſt / Eaſt} Point of the Card or Fly, and ſo that the four Lines on the inſide of the Box, and the four Lines on the Edge of the Card, do always agree.

The Compaſs thus fitted, turn the *Index* towards the Sun, until the Shadow of the ſloap Thred fall directly into the Slit of the Perpendicular Sight, and alſo upon a ſtreight Line in the middle of the *Index*; then at the ſame time will the inner Edge of the *Index* ſhew the *Magnetical Azimuth* from the North or South.

The Uſe of the Azimuth *Compaſs in taking of the Sun's Amplitude.*

If you obſerve the Sun's Amplitude in the {Morning / Evening} at the {Riſing / Setting} of the Sun, then turn the Centre of the *Index* right over the {Weſt / Eaſt} Point of the Fly, and rectifie the Compaſs by the Lines within the Box, and the Lines over the Fly.

Then at the time of the Sun's {Riſing, / Setting,} turn the *Index* towards the Sun, till you cut the Body of the Sun by your *Index* and Thred; then will the inner Edge of the *Index* give you the Degrees and Minutes of the *Magnetical Amplitude* upon the Limb of the Compaſs, from the {Eaſt, / Weſt,} towards either North or South.

The *Magnetical Azimuth* or *Amplitude* being thus obtained: by the *Compaſs*, for the ſame time, you muſt find the true *Azimuth* or *Amplitude*, as is formerly taught.

And

And if the obſerved *Azimuth* or *Amplitude* do agree with the *Magnetical Azimuth* or *Amplitude*, then hath your *Compaſs* no Variation; but if they differ, that difference is the Variation: and which way, towards either *Eaſt* or *Weſt*, is taught how to diſcover by the VI[th] *Chapter* hereof.

Or briefly thus, by the *Azimuth*:

1. In the Forenoon.

If the *Sun's Azimuth* from the *North* part of the *Meridian* by Calculation be {Greater / Leſſer} than the *Magnetical Azimuth* by Obſervation; then is the the Variation {*Eaſtward.* / *Weſtward.*}

2. In the Afternoon.

If the *Sun's Azimuth* from the *North* part of the *Meridian* be {Greater / Leſſer} than the *Magnetical Azimuth*, then is the Variation {*Weſterly.* / *Eaſterly.*}

Briefly thus by the *Amplitude*:

1. At the Sun's Riſing.

If the *Sun's Amplitude* be {nearer to / farther from} the *North* part of the *Meridian* than the *Magnetical*, then is the Variation {*Weſterly.* / *Eaſterly.*}

2. At Sun's Setting.

If the *Sun's Amplitude* be {nearer to / farther from} the *North* part of the *Meridian* than the *Magnetical*, then is the Variation {*Eaſterly.* / *Weſterly.*}

Of the Variation of the Compaſs, *and towards what Coaſt it Varieth.*

The two principal ways for finding the Variation of the *Compaſs*, are by the *Sun's Amplitude* at his Riſing or Setting, and by his *Azimuth* at any other time of the Day.

1. By the Sun's Amplitude.

You are by your *Azimuth Compaſs* to Obſerve at the *Sun's* Riſing or Setting, how many Degrees the *Sun* is from the *Eaſt* or *Weſt* Points of the *Compaſs*; which number of Degrees, if they do exactly agree with the *Amplitude* found, by Calculation or otherwiſe, and be on the ſame Side of the *Meridian*, then hath the *Compaſs* no Variation; but if they differ, look how many Degrees that difference is, for ſo much is the Variation.

For Example, Admit that I find the *Suns* * *Amplitude* for ſome Day or other, to be 24 deg. 52 min. *Northerly:* Then I know that the *Sun* ſhould Set that Evening at almoſt 25 deg. from the *Weſt*, towards the *North*: But at *Sun* Setting, obſerving with my *Azimuth Compaſs*, I find that the *Sun* Sets but 19 Degrees from the *Weſt* towards the *North*: from whence I gather, that the Variation is 5 deg. 52 min. (that is almoſt 6 deg.) And by this means you may Obſerve the Variation as often as opportunity will ſerve.

* *How to find the* Sun's Amplitude *any Day in the Year, in any* Latitude, *is ſhewed in ſeveral Places of this* Book, *and among the* Aſtronomical Problems *following: as alſo the* Sun's Azimuth, *&c.*

To know towards what Coaſt, Eaſt *or* Weſt, *the* Compaſs *Varies.*

I. *By the* Amplitude.

If the Degrees of the *Compaſs*, which ſhould directly reſpect the *Sun* at his Riſing or Setting, (namely the Degrees of *Amplitude* found as before,) be more towards the Right-hand than the *Sun*-Riſing or Setting is, the Variation is *Eaſterly:* But if it be more towards the Left-hand, the Variation is *Weſterly*; becauſe, when you look with

with your Face towards the *North*, the *East* is on your Right-hand, and the *West* on your Left-hand.

As in the former *Example*, I find by the *Amplitude*, that the *Sun* should Set almost 25 deg. from the *West Northerly*; but Setting the *Sun* with my *Compass*, I find that 25 deg. of my *Compass* is more to the Right-hand than 19 deg. the Place of the *Sun*-Setting: therefore I conclude the Variation to be almost 6 deg. *Easterly*; so that the *North* Point of the *Compass* shews not the true *North*, but points almost 6 deg. to the *Eastward* of the *North*: and consequently, all the other Points of the *Compass* direct more towards the Right-hand than they should do: And according to this Rule, the like in all Points is to be understood, if the Observation had been made at the *Sun's*-Rising.

Note, It will be best to make these Observations when the *Sun* seems to be a little above the *Horizon*; namely, when the lower edge of the *Sun* seems almost to touch the *Horizon*: for then is the *Sun* in the *Horizon*, but by reason of his Refraction and Parallax he seems to be above it.

II. *By the Sun's* Azimuth.

The Variation of the *Compass*, by the *Sun's Azimuth*, may be found according to the Directions following, *viz.*

About the middle of the Forenoon or Afternoon (the farther from Noon the better) you must take the *Sun's Altitude* by some *Instrument* for that purpose hereafter mentioned; which being noted down, you are at the same time, as near as may be (or another for you at the same time) to set the *Sun* with your *Compass*, and note down likewise upon what Degree of the *Compass* (reckoning from the *North*) you found the *Sun* to be. Then knowing your *Latitude*, and (by your *Tables*, at the end of this *Book*) the *Sun's Declination*, you may find the *Sun's Azimuth* from the *North*, as hath been shewed how to do several ways, in divers places of this *Book*; which *Azimuth*, compared with the Degrees before found by the *Compass*, if both agree, the *Compass* hath no Variation; if there be any difference, that difference is the Variation: which Variation, whether it be *Easterly* or *Westerly*, may be found by the Rule last delivered for that purpose.

Example, Admit that upon some Day in the Forenoon, I observed the Height of the *Sun* to be 32 deg. 28 min. and knowing my *Latitude*, and *Sun's Declination* for that time, I find the *Sun's Azimuth* from the *North* to be 107 deg. 36 m. At the same time as I took my *Altitude* in the Forenoon, I set the *Sun* by my *Azimuth Compass*, and found that the *Sun* then was 102 deg. the difference between the true observed *Azimuth*, and that by my *Compass* being 5 deg. 36 m. which is the Variation of the *Compass*.

Now to know whether this Variation be *Easterly* or *Westerly*. I consider that the *Sun's* true *Azimuth* (found by the *Astronomical Problems* in this *Book*) from the *North* 107 deg. 36 min. or from the *East* Point of the *Compass Southwards* 17 deg. 36 min. whereas setting the *Sun* with my *Compass* it was but 12 deg. from the *East Southwards*: So that the Degrees that the *Sun* should have been on, was more towards the Righ-hand than the Degrees whereon it was: wherefore, I conclude the Variation to be *Easterly* 5 deg. 36 min.

SECT. III. *Of the Universal* Ring-Dial.

The Description of the several parts of this Dial.

THE Dial consisteth of three Parts, *viz.* Of two great Circles of the Sphere. 1. The *Meridian*, which is the outermost Circle thereof. 2. The *Æquinoctial*, which is the innermost Circle thereof. And, 3. Of a *Bridge* or *Stile*, representing the *Axis* of the World: And to these three General Parts is added this Particular; namely, a small *Ring* and *Index*, to set it to the *Latitude* of the Place in what Part of the World soever you are; and also to hold in your Hand, when you would find either the *Latitude* of a Place, or the Hour of the Day. *Fig.* III.

How

How the several parts of the Dial *are divided.*

1. The *Meridian* on one side is first divided into Four Parts or *Quadrants*, and one of those *Quadrants* divided into 90 equal Parts or Degrees; to one of which the small Ring must be set when you would find the Hour in any *Latitude.*—— On the other-side of the *Meridian* is projected a *Quadrant* of *Altitude*, whereby to take the Height of the *Sun*; and so consequently thereby to find the *Latitude* of an unknown Place, in what Part of the World soever you are.

2. The *Æquinoctial* Circle is divided in the inside thereof; first, into 24 equal Parts or Hours, and those again subdivided into Halves and Quarters, and numbred both ways, by I. II. III. *&c.* to XII. standing at the *Meridian*. And although all the 24 Hours are necessary; Yet in small *Instruments* they seldom do graduate more than from 3 in the Morning till 9 at Night.

3. The *Axis*, *Stile*, or *Bridge*, which passeth cross the *Meridian* Circle from Pole to Pole, always cutting the *Æquinoctial* Circle at Right Angles, is made of a piece of thin (but broad) Brass; in the middle whereof is a long slit, in which there moveth a *Cursor*, which hath in it a small hole, which must be set to the Day of the Month, graduated on the *Axis*, when you would find the Hour of the Day. Or to the *Sun's* Declination, which is graduated on the other side thereof, when you would find the *Latitude* of any unknown Place. Hitherto of the Description: Now shall follow

The Use of this Universal Dial.

The Uses are principally these following. Although larger *Instruments* of this kind may be made to perform divers others.

I. The Day of the Month being known, you may find the *Sun's* Declination: Or,

II. The Declination being known, you may find the Day of the Month.

III. The *Latitude* of the Place you are in, and the *Sun's* Declination being known, you may find the *Meridian-Altitude.* Or,

IV. The *Meridian-Altitude* and Declination being known, you may find the *Latitude.*

V. The *Latitude* and Day of the Month (or Declination) known, you may find the Hour of the Day in any Part of the World.

1. *To find the Sun's Declination.*

Move the *Cursor* with your Thumb along the slit in the *Axis*, till the hole stand just against the Day of the Month, then turn to the other side of the Bridge, and the small hole will stand just against the *Sun's* Declination.

			D. M.
So if you set the hole of the *Cursor* against the	10*th.* of *January*	It will shew on the other side of the Bridge	20 1 S.
	20*th.* of *February*		6 57 S.
	10*th.* of *March*		0 00
	15*th.* of *May*		21 7 N.
	20*th.* of *August*		8 56 N.

And on the 12*th.* of *September* the Declination will be 00 deg. 00 min. again: And by this Example you may perceive that from the 10*th.* of *March*, to the 12*th.* of *September*, the *Sun* hath *North* Declination; and from the 12*th.* of *September*, to the 10*th.* of *March*, it hath *South* Declination.

2. *To find the Day of the Month.*

This is but the converse of the former Proposition: For if you

	D. M.		
Set the *Cursor* to	20— 1 *South*	Declination, and on the other side of the Bridge you shall find	*January* the 10*th.*
	6—57 *South*		*February* the 20*th.*
	0—00		*March* the 10*th.*
	21— 7 *North*		*May* the 15*th.*
	8—56 *North*		*August* the 20*th.*

3. *To*

3. *To find the Sun's* Meridian Altitude.

If the *Sun* have $\left\{\begin{matrix}\textit{North}\\ \textit{South}\end{matrix}\right\}$ Declination $\left\{\begin{matrix}\text{Add}\\ \text{Subtract}\end{matrix}\right\}$ the Complement of the *Latitude* (which is so much as the *Latitude* wants of 90 deg.) $\left\{\begin{matrix}\text{to}\\ \text{from}\end{matrix}\right\}$ the *Sun's* Declination, and the $\left\{\begin{matrix}\text{Summ}\\ \text{Remainer}\end{matrix}\right\}$ will be the *Meridian Altitude* of the *Sun* that Day: Thus

	D. M.		D. M.		D. M.	
The *Latitude* being	51 30	Complement	38 30		38 30	
And the Declination			16 20	*North* or	16 20	*South.*
The *Meridian Altitude* will be			54 50		22 10	

4. *To find the* Latitude.

This must be performed by Observation: and the Observation that you are to make is of the *Sun's Meridian Altitude*; to perform which stick a Pin in the hole which is on that side of the *Meridian* on which the *Quadrant* of *Altitude* is graduated. Then bring the small *Hand-Ring* to the beginning of the Degrees on the other side of the *Quadrant*, and turn the Pin to the *Sun*, till it cast its Shadow through the Degrees of the *Quadrant* of *Altitude*: then what Degree the Shadow of the Pin cuts, that is the *Sun's Altitude* at that time: So then to observe his *Meridian Altitude* (which is always at 12 a Clock) you must about Noon wait till you see the *Sun* at his greatest *Altitude*, for that (in these temperate *Zones*) is the *Meridian Altitude*.

The Meridian Altitude *being obtained, the* Latitude *is thus found.*

Add the *Meridian Altitude* and the *Sun's* Declination together, if the Declination be *South*, (or subtract the Declination from the *Meridian Altitude*, if the Declination be *North*,) and the Summ or Difference shall be the Complement of the *Latitude* of the Place. Thus,

The *Meridian Altitude* being $\left\{\begin{matrix}54-50\\ 22-10\end{matrix}\right\}$ (D. M.) and the Declination $\left\{\begin{matrix}16 & 20\ \textit{North},\\ 16 & 20\ \textit{South},\end{matrix}\right\}$ (D. M.) the Complement of the *Latitude* will be found to be 38 deg. 30 min. which taken from 90 deg. leaves 51 deg. 30 min. for the true *Latitude*.

5. *To find the Hour of the Day.*

First, Set the *Hand-Ring* to the *Latitude* of the Place, and the hole in the *Cursor* to the Day of the Month, then open the *Equinoctial* Circle at Right Angles to the *Meridian* Circle, and turn the *Axis* towards the Hour of the Day you guess it to be: Then holding the *Hand-Ring* between your Forefinger and Thumb, guide the *Meridian* Circle, by help of your little Finger, to the *Sun*, so that the Beams may pass through the hole of the *Cursor*, and pierce upon the middle of the *Equinoctial* Circle, where the Hours, Halves, and Quarters are graduated; so shall the little spot of Light there shew the Time and Hour of the Day.

SECT. IV. *Of the* Cross-Staff, *or* Fore-staff.

The Description of the Cross-Staff.

THE Staff is made in length about three Foot, and four Square, each Side being about half or three quarters of an Inch square broad: Each of these Sides is divided into unequal Parts, as a Line of *Tangents* is, *Fig.* IV.

The Divisions of the $\left\{\begin{matrix}\text{First}\\ \text{Second}\\ \text{Third}\\ \text{Fourth}\end{matrix}\right\}$ Side begin at $\left\{\begin{matrix}3\\ 10\\ 20\\ 30\end{matrix}\right\}$ (D.) and end at $\left\{\begin{matrix}10\\ 30\\ 60\\ 90\end{matrix}\right\}$ (D.)

To

To theſe Four Sides belong a ſeveral Croſs or Vane: As

To the Side of D.	uſe the D.	Vane, which ſerves for all *Altitudes* between D.	and D.
10	10	0	10
30	30	10	30
60	60	30	60
90	90	60	90

The Uſe of this Staff.

It principally is uſed in taking of the *Altitude* of the *Sun*, *Moon*, or *Stars* : And according (as by eſtimation) you gueſs the *Altitude* of the *Sun* or *Star* to be, accordingly put upon your Staff the Tranſome proper for ſuch an *Altitude*.

How to make your Obſervation.

Hold the end of your Staff to the corner of your Eye, and there let it reſt upon the Eye-Bone, as near the Centre of your Eye as you can with convenience, ſo that it hinder not your Sight : Then look to the upper end of your Croſs, to the *Sun* or *Star*, and at the lower end of the Croſs for the *Horizon* ; but if you cannot ſee the *Horizon* at the lower end, but you ſee all Sky and no Water, then draw your Croſs a little nearer to your Eye : but, on the contrary, if you ſee all Water and no Sky, then ſlide your Croſs a little from your Eye, and then make Obſervation again as before: Then if you ſee the Centre of the *Sun* or *Star* at the upper end of the Croſs, and the *Horizon* at the lower end, then your Croſs doth ſtand as it ought. Then wait till the *Sun* be upon the *Meridian*, and make Obſervation again as often as you think convenient; and as you find the *Sun* to riſe higher, draw your Croſs a little nearer to your Eye ; but if the *Sun* be fallen, then you will not ſee the *Horizon*, for the Water will hinder ; and in ſuch caſe you muſt not alter your Croſs, but look upon that Side of your Staff unto which your Croſs belongeth : and thoſe Degrees and Minutes that the Croſs doth ſtand at upon its proper Side of the Staff is the *Meridian Altitude* for that day.

SECT. V. *Of the* Quadrant, *or* Back-Staff.

The Deſcription of the Quadrant.

Fig. V. THIS *Quadrant* is the principal *Inſtrument* now in Uſe at Sea, for taking the *Meridian Altitude* of the *Sun* : It was the Invention of one Captain *Davis*, an *Engliſh* Man, and called *Davis's Quadrant*.

The Parts of this Inſtrument *are Two.*

(1.) Three *Vanes* ; and (2.) Two *Arches*.

The three *Vanes* are, (1.) The *Sight-Vane*. (2.) The *Horizontal-Vanes*. (3.) The *Shade-Vane*.

It is called the *Shade-Vane*, becauſe in time of Obſervation it giveth the Shadow upon the *Horizontal-Vane* : And the *Sight-Vane* is ſo called, becauſe it is placed at the Eye in time of Obſervation.

The leſſer *Arch* is called the *Arch of* 60 deg. and the greater, the *Arch of* 30 deg. which together make 90 deg. and from thence it is denominated a *Quadrant*.

The 60 *Arch* may be divided into 60 deg. but every Fifth is ſufficient, and numbered downwards by 10, 20, 30, *&c.* to 60. —— The greater *Arch* is called the 30 *Arch*, and is divided into 30 deg. and by *Concentrick* Circles and *Diagonal* Lines ſub-divided into 5 or 10 min.

The Uſe of the Quadrant.

Firſt, Put the *Horizontal-Vane* upon the end of the *Quadrant* ; and then the upper edge of the *Shade-Vane* upon the 60 *Arch*, at ſome even 5 or 10 deg. as you ſhall

ſee cauſe; and laſtly, put the Sight-Vane upon the 30 Arch. Your *Quadrant* being thus fitted, when you begin to take the Altitude with it, you muſt turn your Back to the Sun, and hold the Handle of your *Quadrant* with the Sight-Vane to your Eye, as upright as you can.

Then look through the Sight-Vane upon the Horizon-Vane, and bring the upper part of the Shade to lie upon the upper part of the Edge of the Slit of the Horizon-Vane, and at the ſame time look for the Horizon through the Slit of the Horizon-Vane; and if you cannot ſee the Horizon, but all Sky and no Water, then put your Sight-Vane a little lower; but if you ſee all Water and no Sky, then put your Sight-Vane a little higher; and when you have done ſo, obſerve again; and then, if you ſee the Shade fall upon the upper part of the Slit of the Horizon-Vane, and at the ſame time you ſee the Horizon through the Sight Vane, it is all at preſent you have to do.

Then wait till the Sun be upon the Meridian, and make Obſervation as often as your Judgment ſhall think fit, until you find the Sun at the higheſt; for if the Sun be fallen, and you go to obſerve, you will not ſee the *Horizon*, for the Water will hide it from you: Then look what Degrees do ſtand by the upper Edge of your Sight-Vane, and add them to the Degrees to which you ſet your Shade Vane, and their Summ is the Diſtance of the upper Edge of the Sun from the *Zenith*; to which Summ if you add 16 min. for the Sun's Semidiametre, you will have the true Diſtance of the Sun's Centre from the *Zenith*, whoſe Complement is the Sun's Meridian Altitude: But if you obſerve by the lower part of the Shade, then it is the lower Limb of the Sun that gives the Shade: Therefore, if you obſerve by the upper part of the Shade, you muſt add 16 min. but if by the lower part of the Shade, you muſt add or ſubtract 16 min. to or from the obſerved Altitude, and the Summ or Remainder is the Diſtance of the Sun's Centre from the *Zenith*, or the Complement of the Meridian Altitude.

There are other Inſtruments for taking of the Altitude of the Sun and Stars; as the *Plough*, the *Aſtrolabe*, the *Demi-Croſs*, the *Bow*, *&c.* whoſe Deſcription I here purpoſely omit, as being, moſt of them, not made uſe of by our *Engliſh* Navigators.

SECT. VI. *Of the Nocturnal.*

THere are ſeveral ſorts of *Nocturnals*, of which ſome are Projections of the Sphere, as the two Hemiſpheres mentioned in the Second Part of the Third Book of *Practical Aſtronomy*; but with Seamen there are only Two, which they generally make uſe of, and the manner of uſing of either of them is the ſame. One of them is fitted to be uſed with the *North-Star*, and the firſt of the *Guards* in the *Little Bear*; the other for the *North-Star*, and the *Guards*, (or *Pointers*, as ſome call them,) of the *Great Bear*. *Fig.* VI.

The *Nocturnal* conſiſts of three Parts, or Piecees of Wood or Braſs, the largeſt of which hath a Handle to hold it by when you would obſerve, and oppoſite to the Handle a ſmall Tooth or Point, which (if it be made for the *Little Bear*) ſtands againſt the 25th. of *April*, but if for the *Great Bear*, againſt the 17th. of *February*, which are the times that thoſe Stars come to the Meridian at 12 a Clock at night. Upon this bigger Piece or Part are two Circles deſcribed, in the outermoſt of which are the Months and Days of the Month, and upon the innermoſt the 24 Hours of a natural Day; and upon the back ſide of this part alſo are deſcribed and marked with Letters the 32 Points of the Compaſs.

The ſecond Part of the *Nocturnal* hath two Circles deſcribed upon it; the outermoſt whereof is divided into 29 and a half equal Parts, for the Days of the Moons Age, and the innermoſt into 24 Hours; and at the beginning of the Days of the Moons Age, and at XII, there is a Tooth to be ſet to the Day of the Month in the Upper Part.

The third Part is an *Index* with a Fiducial Edge iſſuing from the Centre, and muſt be ſo long that a good part of it may extend beyond the outermoſt or biggeſt Piece. Theſe three Parts are ſo ordered, that by help of a ſmall hollow Braſs Socket they are made to move about the Centre of the Inſtrument; all which do plainly appear in the Figure thereof.

The Use of the Nocturnal.

I. *To find the Hour of the Night.*

Set the Tooth which is upon the middle Part to the Day of the Month; then looking towards the North, hold up the Instrument as upright as you can, the Fore-side being towards your Face: Then bow the upper part of the *Nocturnal* where the Tip is, so much towards you, that through the Hole which is in the Centre of the Instrument you may see the *North* or *Pole-Star*, and there hold it fast, turning the long *Index* about, till by the Edge thereof you can see the first of the *Guards* of the *Little Bear*, or the *Pointers* of the *Great Bear*, [according to which *Bear* the Instrument is made;] then shall the Edge of the *Index* or Ruler shew upon the innermost Circle of the Middle Part the Hour of the Night.

II. *To find upon what Point of the Compass the* Guards *are.*

When you have observed and found the Hour of the Night, as is before directed, let the Long Ruler or *Index* rest in its place that it was in when you observ'd the Hour, and then turn the Back-side of the Instrument, and upon what Point of the Composs the *Index* lies, upon that Point of the Compass were the *Guards* at the time of your Observation.

III. *To find at what Hour the Moon will be upon the South Part of the Meridian, at any Day of her Age.*

Seek the Days of the Moon's Age upon the outermost Circle of the Middle Piece, and right against it, in the innermost Circle of that Piece, is the Hour required.

Example. If upon the 18th or other Day of *May*, the Moon shall be found to be 11 days old, look for 11 in the outermost Circle, and against it in the innermost Circle you shall find VIII Hours and 48 min. at which time the Moon will be upon the Meridian when she is 11 days old.

CHAP. III.

Concerning the Finding of the Latitude *at Sea.*

IN the Fourth and Fifth *Sections* of the foregoing *Chapter* you have the Description and Use of the two principal Instruments for taking the Altitudes of the Sun or Stars, either upon the Meridian, or upon other Points of the Compass: It resteth now to shew, how these Observations are to be applied to Practice, in finding of the *Latitude*: For the obtaining of which, by the Meridian Altitude of the Sun or of a Star, mind these following

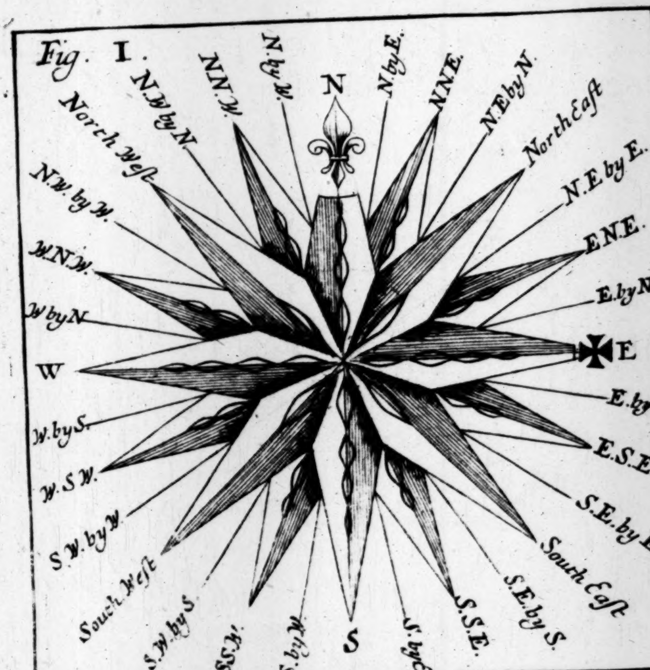
RULES.

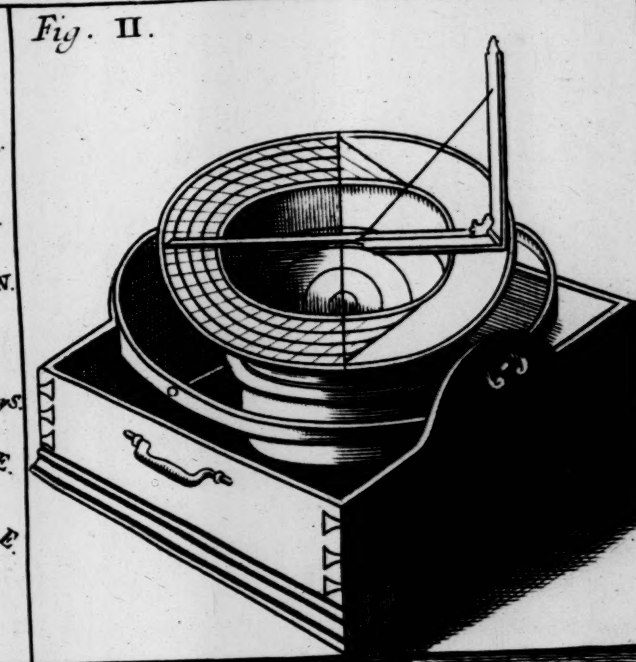
1. *Note,* That so much as the *Zenith* (which is always the Complement of the Meridian Altitude to 90 deg.) is distant from the *Equinoctial* towards the North or South, so much is the respective (North or South) *Pole* elevated above the *Horizon*, and that is called *LATITUDE*.

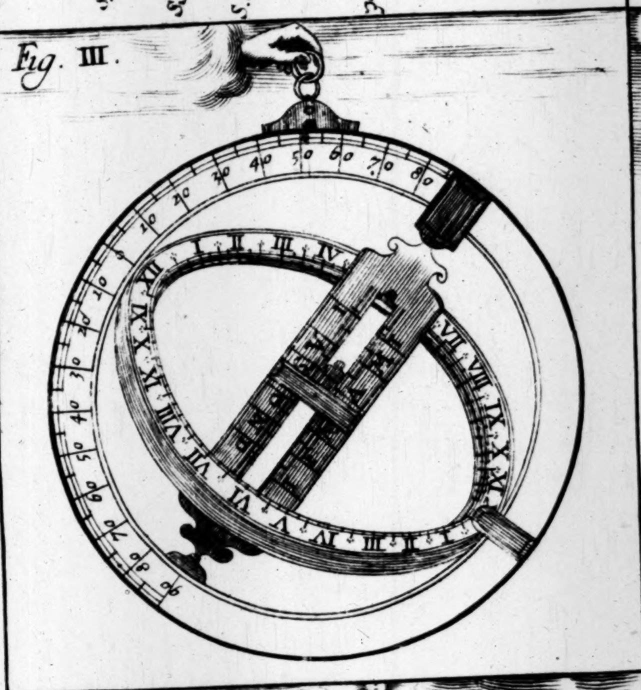
2. If the Sun or Star have no Declination, the *Zenith* Distance (or Complement of its Meridian Altitude) is the *Latitude*: And then, If the Sun or Star be upon the North part of the Meridian, the *Latitude* is South; if upon the South part of the Meridian, the *Latitude* is North.

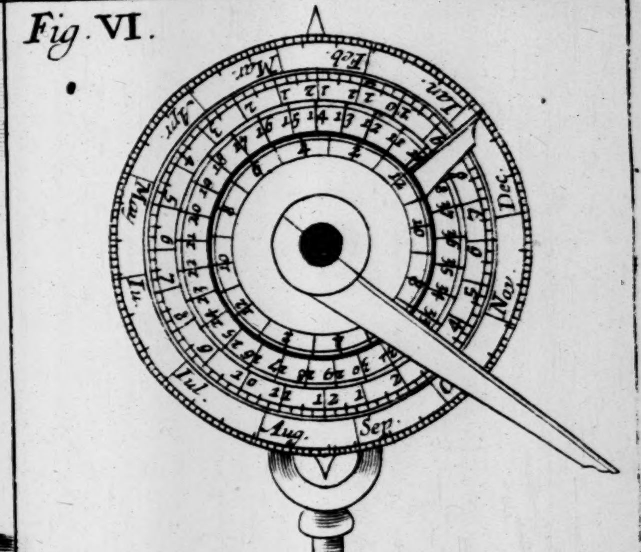
3. If the Sun or Star be in the *Zenith*, then the Declination of the Sun, or of that Star, is the *Latitude*: And if the Declination be Northerly, the *Latitude* is North; if Southerly, South.

4. In all other Cases, the Position of the *Zenith*, the *Equinoctial*, and the Sun or Star, are to be considered; as, (1.) Whether the *Zenith* be between the *Equinoctial* and the Star; or, (2.) The Star between the *Equinoctial* and the *Zenith*; or, (3.) The









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(3.) The *Equinoctial* between the other two: For, according to these several Situations must the Rules for finding the ***Latitude*** be varied. But the Position of the ***Zenith*** is known, it being, always, the Complement of the Meridian Altitude to 90 deg. and by that, and the Declination, the ***Latitude*** may be obtained.

5. If the Declination of the Sun, or of a Star, be North or South, and the Meridian Altitude observed be the same way with the Declination, the Difference between the Declination and ***Zenith*** Distance is the ***Latitude*** towards that Coast, North or South, as the Declination is.

And that these Rules (here deivered) may be made obvious in all Cases, I shall give particular Examples of them in the following Schemes; in all which,

H Æ Z P O N representeth the Meridian.
Æ æ the Equinoctial.
K A the Parallel of Declination.
H O the Horizon.
P S the *Axis* of the *Æquator* or World.
Z N the Prime Vertical Circle.
P the North Pole.
S the South Pole.

Z the *Zenith*.
N the *Nadir*.
H the South Point of the Horizon.
O the North Point thereof.
H K, or O K, the Meridian Altitude.
Z K the *Zenith* Distance.
Æ K the Sun or Stars Declination.
Z Æ, or O P, the *Latitude*.

Fig. I.

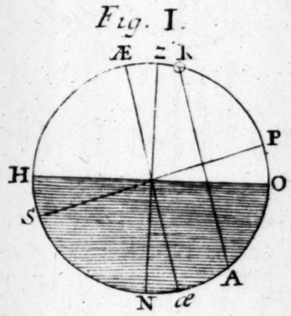


Fig. II.

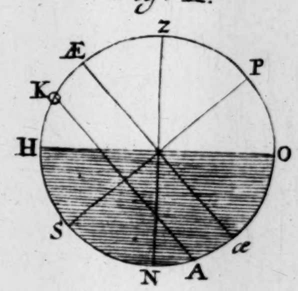


Fig. III.

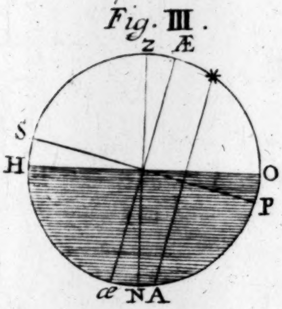


Fig. IV.

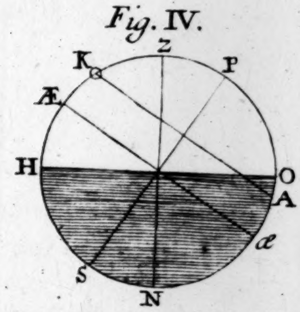


Fig. V.

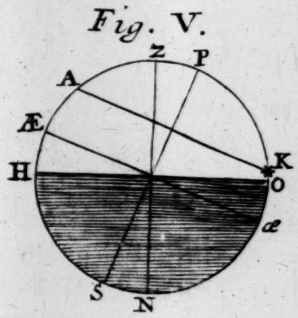


Fig. VI.

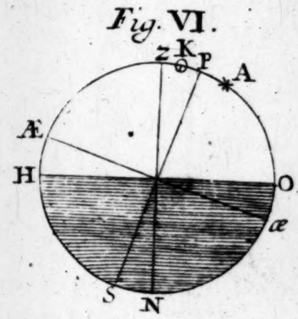
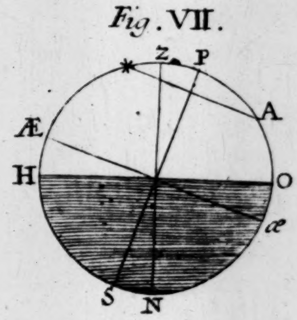


Fig. VII.



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		Deg.	min.	
Fig. I. The *Zenith* being between the *Equinoctial* and the Sun or Star,	The Declination North	23	30	Æ K.
	The *Zenith* Distance North	8	30	Z K.
	The Latitude North	15	00	Z Æ.

But

But if the Declination be less than the *Zenith* Distance, then the contrary Pole to the Declination is elevated.

Fig. II. The *Equinoctial* betwen the *Zenith* and the Sun or Star,	The *Zenith* Distance	71	30	Z K.
	The Declination South	20	00	Æ K.
	The Latitude North	51	30	P O.

Fig. III. The *Zenith* between the *Equinoctial* and the Sun or Star,	The *Zenith* Distance North	30	00	Z K.
	The Declination North	20	00	Æ K.
	The Latitude South	10	00	Z Æ.

But if the *Zenith* Distance be contrary to the Declination of the Sun or Star, the Summ of the *Zenith* Distance and Declination is the *Latitude* North or South, as the Declination is.

Fig. IV. The Summ between the *Zenith* and *Equinoctial*,	The *Zenith* Distance South	31	30	Z K.
	The Delination North	20	00	Æ K.
	The Latitude North	51	30	Z Æ.

Fig. V. The Summ between the *Zenith* and the *Equinoctial*,	Declination North its Comp.	66	30	P K.
	Meridian Altitude North	8	30	O K.
	Latitude North	75	00	O P.

But if the Meridian Altitude be more than the Declination, subtract the *Zenith* Distance from the Complement of the Declination, and the Remainder is the Height of the Pole, North or South, with the Declination.

Fig. VI. The *Zenith* between the *Equinoctial* and the Sun or Star,	The Declination North	80	00	Æ K.
	The *Zenith* Distance North	5	00	Z K.
	The *Latitude* North	75	00	Z Æ.

But here note, That which way soever the Meridian Altitude be, if the Meridian Altitude and twice the Complement of the Declination, (added together,) be less than 180 deg. the Sun or Star hath two Meridian Altitudes; and by the Second Rule you may have the *Latitude*.

Fig. VII. The Sun or Star between the *Equinoctial* and the *Zenith*,	The Meridian Altitude	77	00	H K.
	Declination North 62 deg.	28	00	K P.
	Its Complement twice	28	00	K A.
	The Summ is	133	00	H A.

Which being less than 180 Degrees, therefore,

The *Zenith* Distance South	13	00	K Z.
The Declination North	62	00	Æ K.
The Latitude North	75	00	Z Æ.

CHAP.

CHAP. IV.

Concerning the Vulgar Notes *of the* Julian Year, *the Motion of the* Sun *and* Moon, *with brief Rules and Tables to find them for ever; and of their great Use in* Navigation.

OF ſome of theſe I have had occaſion to ſpeak in the Fourth Book of *COSMOGRAPHY*, and alſo in the Second Part thereof, and alſo at the end of this Seventh Book: Thoſe of the *Vulgar Notes* that I ſhall ſpeak of here, are theſe:

I. Of the *Prime* or *Golden Number*, whereby to find the *Conjunctions*, *Oppoſitions*, and other *Aſpects*, between the Sun and Moon.
II. The *Solar Circle*, (or *Cycle* of the *Sun*,) whereby to find the *Dominical Letter*.
III. The *Epact*, whereby the Difference between the *Solar* and the *Lunar Years* is equated.

SECT. I. *Of the* Prime, *or* Golden Number.

THis is a Circle or Revolution of 19 Years, in which time the Ancients thought that all the *Lunations* and *Aſpects* between the Sun and Moon did return to the ſame place they were at 19 Years before: But Experience hath found the contrary; for they will ſometimes differ 10, 12, or more Hours; notwithſtanding, for the Purpoſes here intended, they will be ſufficiently exact.

> Meton (*th'* Athenian) *firſt this* Circle *found*,
> *Which Nineteen Civil Years devolveth round:*
> *For all* Lunations *make return therein,*
> *Nigh to the Place where firſt they did begin.*

To find this Number for any Year paſt or to come, add 1 to the Year of our Lord, (for this Number was 1 at the Birth of our Saviour,) and divide by 19, the the Quotient will tell you how many Revolutions this Circle hath made ſince the Birth of our Saviour, and the Remainder is the *Prime* or *Golden Number* for the Year enquired.

So in the Year 1691 add 1 to it, it makes 1692; which divide by 19, the Quotient is 89; which ſhews, that ſince the Birth of *Chriſt*, this *Cycle* hath made 89 compleat Revolutions, and 1 more of the 90th. which 1 remaining, is the *Prime* or *Golden Number* for the Year 1691.

TABLE I.						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
A larger TABLE, shewing the PRIME or Golden Number for ever.						100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900
						2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	3000	3100	3200	3300	3400	3500	3600	3700	3800
1	20	39	58	77	96	7	12	17	3	8	13	18	4	9	14	19	5	10	15	1	6	11	16	2
2	21	40	59	78	97	8	13	18	4	9	14	19	5	10	15	1	6	11	16	2	7	12	17	3
3	22	41	60	79	98	9	14	19	5	10	15	1	6	11	16	2	7	12	17	3	8	13	18	4
4	23	42	61	80	99	10	15	1	6	11	16	2	7	12	17	3	8	13	18	4	9	14	19	5
5	24	43	62	81		11	16	2	7	12	17	3	8	13	18	4	9	14	19	5	10	15	1	6
6	25	44	63	82		12	17	3	8	13	18	4	9	14	19	5	10	15	1	6	11	16	2	7
7	26	45	64	83		13	18	4	9	14	19	5	10	15	1	6	11	16	2	7	12	17	3	8
8	27	46	65	84		14	19	5	10	15	1	6	11	16	2	7	12	17	3	8	13	18	4	9
9	28	47	66	85		15	1	6	11	16	2	7	12	17	3	8	13	18	4	9	14	19	5	10
10	29	48	67	86		16	2	7	12	17	3	8	13	18	4	9	14	19	5	10	15	1	6	11
11	30	49	68	87		17	3	8	13	18	4	9	14	19	5	10	15	1	6	11	16	2	7	12
12	31	50	69	88		18	4	9	14	19	5	10	15	1	6	11	16	2	7	12	17	3	8	13
13	32	51	70	89		19	5	10	15	1	6	11	16	2	7	12	17	3	8	13	18	4	9	14
14	33	52	71	90		1	6	11	16	2	7	12	17	3	8	13	18	4	9	14	19	5	10	15
15	34	53	72	91		2	7	12	17	3	8	13	18	4	9	14	19	5	10	15	1	6	11	16
16	35	54	73	92		3	8	13	18	4	9	14	19	5	10	15	1	6	11	16	2	7	12	17
17	36	55	74	93		4	9	14	19	5	10	15	1	6	11	16	2	7	12	17	3	8	13	18
18	37	56	75	94		5	10	15	1	6	11	16	2	7	12	17	3	8	13	18	4	9	14	19
19	38	57	76	95		6	11	16	2	7	12	17	3	8	13	18	4	9	14	19	5	10	15	1

The Uſe of this Table.

In this Table you have, in ſix little Columns, all Numbers of Years, ſucceſſively proceeding, from 1 to 100, by 1, 2, 3, 4, *&c.* to 99: —— And in two Rows at the Head of the Table, you have all Numbers of Hundreds of Years, ſucceſſively increaſing, from 100 to 3800, in this order, 100, 200, 300, *&c.* to 3800.

Now the Uſe of this Table is plain: For if you find the Hundreds or Thouſands of Years propoſed in the Head of the Table, and the other odd Number of Years in any of the ſix little Columns on the Left-hand of the Table, in the common Angle, or meeting of thoſe two, you have the *Prime* for that Year.

Example 1. *I would know what was the* Prime *or* Golden Number *in the Year of our Lord* 1529.—— Look for 1500 in the Head of the Table, (which you will find in the Fifteenth Column,) and look for 29 on the Left-hand of the Table, (which you ſhall find in the ſecond of the ſix little Columns,) and right againſt 29, and under 1500, you ſhall find 10; and ſuch was the *Prime* or *Golden Number* for the Year 1529.

Example 2. *Let the* Prime *or* Golden Number *be required for the Year* 2672.—— Look for 2600 in the Head of the Table, and for 72 in the Left-hand ſmall Columns, and againſt 72, and under 2600, you ſhall find 13, which will be the *Prime* for the Year 2672, *&c.*

SECT.

SECT. II. *Of the* Solar Circle, *or* Cycle *of the* Sun.

THIS Circle maketh its periodical Revolution in 28 Years; and was invented, more to find thereby the true order of the *Dominical Letters*, than to shew any great Changes of the *Sun's* Motion therein.

> *Seven* Hebdomaick *Letters used be,*
> *And those are* A,B, C, D, E, F, G:
> *The* Solar Circle *shews us which to call,*
> *The* Sunday-Letter, *or* Dominical.

To find this Number for any time; add 9 to the Year given, and divide by 28, the Remainder, after the Division is ended, shews the *Cycle* of the *Sun* for that Year.

So in the Year 1691, add 9 to it, and it makes 1700; which divided by 28, gives 60 in the *Quotient*, and 20 remaining; which 20 is the *Cycle* of the *Sun* for the Year 1691.

TABLE II.

A TABLE shewing the Dominical Letter *from the First Year of* Christ *to* 3400.				1	2	3	4	5	6	7
				000	100	200	300	400	500	600
				700	800	900	1000	1100	1200	1300
				1400	1500	1600	1700	1800	1900	2000
				2100	2200	2300	2400	2500	2600	2700
				2800	2900	3000	3100	3200	3300	3400
0	28	56	84	D C	E D	F E	G F	A G	B A	C B
1	29	57	85	B	C	D	E	F	G	A
2	30	58	86	A	B	C	D	E	F	G
3	31	59	87	G	A	B	C	D	E	F
4	32	60	88	F E	G F	A G	B A	C B	D C	E D
5	33	61	89	D	E	F	G	A	B	C
6	34	62	90	C	D	E	F	G	A	B
7	35	63	91	B	C	D	E	F	G	A
8	36	64	92	A G	B A	C B	D C	E D	F E	G F
9	37	65	93	F	G	A	B	C	D	E
10	38	66	94	E	F	G	A	B	C	D
11	39	67	95	D	E	F	G	A	B	C
12	40	68	96	C B	D C	E D	F E	G F	A G	B A
13	41	69	97	A	B	C	D	E	F	G
14	42	70	98	G	A	B	C	D	E	F
15	43	71	99	F	G	A	B	C	D	E
16	44	72		E D	F E	G F	A G	B A	C B	D C
17	45	73		C	D	E	F	G	A	B
18	46	74		B	C	D	E	F	G	A
19	47	75		A	B	C	D	E	F	G
20	48	76		G F	A G	B A	C B	D C	E D	F E
21	49	77		E	F	G	A	B	C	D
22	50	78		D	E	F	G	A	B	C
23	51	79		C	D	E	F	G	A	B
24	52	80		B A	C B	D C	E D	F E	G F	A G
25	53	81		G	A	B	C	D	E	F
26	54	82		F	G	A	B	C	D	E
27	55	83		E	F	G	A	B	C	D

The

The Use of this Table.

This *Table*, in its Use, differeth little from the former, for if you find the Hundreds, or Thousands of Years in the Head of the *Table*, and the odd Tens of Years in any of the Four lesser Columns to the Left-hand; in the common *Angle*, or meeting of these two, is found the *Dominical* or *Sunday-Letter* for that Year.

Example 1. *I would know what the* Dominical-Letter *was in the Year of our Lord* 1626— Look for 1600 in the Head of the *Table*, (which you will find in the Third Column,) and look for 26 in the Four small Columns, (which will be found in the First of the Four Columns,) and right against 26, and under 1600, you shall find A; which was the *Dominical-Letter* for the Year 1626.

Example 2. *What will the* Dominical-Letter *be in the Year* 1864.— Look for 1800 in the Head of the *Table*, and for 64 in the Four small Columns, and against 64, and under 1800, you shall find E D, which are the *Dominical-Letters* for that Year. And because it hath two Letters, it appeareth to be a *Leap-Year*: The first Letter E being in Use till the 24*th*. of *March*, and the latter D, to the end the Year.

SECT. III. *Of the* Epact.

THE *Epact* is a Number never exceeding 30, because the *Moon* between Change and Change never exceeds 30 days, and thereby the common *Lunar Year*, consisting of 13 Months, is less than the *Solar Year* by 11 days; for to every Month are attributed but 29 days and a half: so that a *Lunar Year* containeth but 354 days; and the common *Solar Year* consisting of 365 days, exceedeth the other by 11 days: from whence the *Epact* taketh its Original.

> Epactæ *from* ἐπάγειν, *is deriv'd*,
> *They'r adventitious Days fitly contriv'd*
> *To adequate the Difference that appears*,
> *Betwixt the* Solar *and the* Lunar Years.

To find the *Epact* for any Year, you must by *Section* I. find the *Golden Number* for that Year; which multiply by 11, and divide the Product by 30, the Remainder, after the Division is ended, shall be the *Epact* for that Year.

So in the Year 1691, the *Golden Number* for that Year is 1; which multiplied by 11, the Product will be 11; which should be divided by 30; but being less than 30, 11 is the *Epact* of the Year 1691.

TABLE III.

A *Table* shewing the *Epact* for ever.

1690	29
1691	11
1692	12
1693	13
1964	14
1695	25
1696	16
1697	17
1698	18
1699	19
1700	10
1701	1
1702	12
1703	23
1704	4
1705	15
1706	26
1707	7
1708	18

Likewise in the Year 1694, the *Golden Number* for that Year is 4; which multiplied by 11, the Product is 44; and that divided by 30, the *Quotient* is 1, and 14, the Remainder, is the *Epact* for 1694.

The Use of this *Table*: Seek the Year of Christ in the First Column of the *Table*, and right against it, in the Second, you shall have the *Epact*.

So in the Year 1691, I would know the *Epact* for that Year, seek for 1691 in the First Column, and right against it stands 11; which is the *Epact* for the Year 1691.

If you would know the *Epact* for any Year after 1708, you must begin the Column of Years again, calling 1690 1709, *&c.* So shall the *Epact* for the Year 1712 be found to be 3, and of 1722 to be 23, *&c.*

And here note, That the *Golden Number*, the *Cycle* of the *Sun*, and the *Dominical Letter*, take their beginning every Year on the First of *January*: but the *Epact* taketh its beginning not till the First of *March*.

TABLE

TABLE IV.

A TABLE shewing in what Sign and Degree of the Zodiack *the Sun is every Day in the Year at* 12 *at Noon.*

Months.	*January.*	*February.*	*March.*	*April.*	*May.*	*June.*	*July.*	*August.*	*September.*	*October.*	*November.*	*December.*
Days	♑	♒	♓	♈	♉	♊	♋	♌	♍	♎	♏	♐
1	22	23	21	22	21	21	19	19	19	18	19	20
2	23	24	22	23	22	22	20	20	20	19	20	21
3	24	25	23	24	23	23	21	21	21	20	21	22
4	25	26	24	25	24	24	22	22	22	21	22	23
5	26	27	25	26	25	25	23	23	23	22	23	24
6	27	28	26	27	26	26	24	24	24	23	24	25
7	28	29	27	28	27	27	25	25	25	24	25	26
8	29	♓	28	29	28	28	26	26	26	25	26	27
9	♒	1	29	♉	29	29	27	27	27	26	27	28
10	1	2	♈	1	♊	♋	28	28	28	27	28	29
11	2	3	1	2	1	1	29	29	29	28	29	♑
12	3	4	2	3	2	2	♌	♍	♎	29	♐	1
13	4	5	3	4	3	3	1	1	1	♏	1	2
14	5	6	4	5	4	4	2	2	2	1	2	3
15	6	7	5	6	5	5	3	3	3	2	3	4
16	7	8	6	7	6	6	4	3	4	3	4	5
17	8	9	7	8	7	7	5	4	5	4	6	6
18	9	10	8	9	8	7	6	5	6	5	7	7
19	10	11	9	10	9	8	7	6	7	6	8	8
20	11	12	10	11	10	9	8	7	8	7	9	9
21	12	13	11	12	11	10	8	8	8	8	10	10
22	13	14	12	13	12	11	9	9	9	9	11	11
23	14	15	13	13	13	12	10	10	10	10	12	12
24	15	16	14	14	14	13	11	11	11	11	13	13
25	16	17	15	15	15	14	12	12	12	12	14	14
26	17	18	16	16	16	15	13	13	13	13	15	15
27	18	19	17	17	17	16	14	14	14	14	16	16
28	19	20	18	18	18	17	15	15	15	15	17	17
29	20		19	19	19	18	16	16	16	16	18	18
30	21		20	20	20	19	17	17	17	17	19	19
31	22		21		21		18	18		18		20

The Use of this Table.

The Uſe of this *Table* is very eaſie, for if you find the Month in the Head of the *Table*, and the Day of the Month in the firſt Column, towards the Left-hand, in the common Angle of Meeting you have the Sign and Degree in which the *Sun* is that Day at Noon.

Example. On the 4*th.* of *February*, look for *February* at the Head of the *Table*, and 4 in the firſt Column; then under *February*, and againſt 4 in the firſt Column, you ſhall find 26, and the Character of ♓ *Piſces* at the Head, which ſhews the *Sun* is in 26 deg. of *Piſces* on the 4*th.* of *February* at Noon.— Alſo, upon the 17*th.* of *October* the *Sun* will be found to be in 4 degrees of ♍ *Scorpio*, &c.

TAB.

TABLE V.

A TABLE shewing the Day, and Hour of the Day, upon which the Moon Changes in every Month, till the Year 1702; and may indifferently serve for the Purposes it is in this place intended, till the Year 1721.

Years of Christ.	January		February		March		April		May		June		July		August		September		October		November		December		Golden Num.
	D.	H.	D.	H.	D.	H.	D.	H.	D.	H.	D.	H	H.	D.	D.	H.	D.	H.	D.	H.	D.	H	D.	H.	
1682	28	4	26	21	28	21	26	22	26	7	24	14	23	22	22	4	20	14	20	2	18	16	18	8	11
1683	17	2	15	22	17	17	16	6	15	19	14	5	13	14	11	21	10	6	9	15	8	1	7	14	12
1684	6	5	4	23	5	15	4	8	4	1	2	14	2	3	1/29	17/22	28	7	27	17	26	3	25	15	13
1685	24	4	22	18	24	9	23	1	22	18	21	8	20	22	19	10	17	22	17	9	15	18	15	6	14
1686	13	19	12	3	13	15	12	4	11	19	10	10	10	1	8	15	7	6	6	20	5	10	4	21	15
1687	3	9	1	18	3	4	1	14	1/31	0/12	29	2	28	17	27	8	26	1	25	18	24	10	23	23	16
1688	22	10	20	20	21	6	19	14	18	22	17	8	16	20	15	10	14	1	13	20	12	13	12	7	17
1689	10	22	9	11	10	21	9	7	8	14	6	20	6	6	4	15	3	4	2	20	1	13	1/31	8/0	18
1690	29	20	28	0	29	22	28	7	27	15	25	20	25	5	23	13	22	1	21	15	20	7	20	2	19
1691	18	23	17	17	19	8	17	20	17	7	15	15	14	21	13	6	11	13	10	23	9	13	9	4	1
1692	7	21	6	17	7	11	6	4	5	18	4	4	3	13	1/31	21/0	29	14	29	0	27	11	27	2	2
1693	25	18	24	10	26	4	24	22	24	11	23	1	22	11	20	21	19	7	18	16	17	2	16	12	3
1694	15	1	13	14	15	6	13	22	13	14	12	4	11	19	10	8	8	20	8	8	6	17	6	5	4
1695	4	14	3	2	4	13	3	1	2	16	1	5	1/31	0/12	29	3	27	18	27	7	25	18	25	8	5
1696	23	16	22	3	22	12	20	23	20	10	18	23	18	13	17	4	15	21	15	14	14	6	13	20	6
1697	12	10	10	18	12	5	10	13	9	21	8	7	7	17	6	6	4	22	4	16	3	9	3	3	7
1698	1/31	21/0	4	0	1/31	1/9	29	13	28	20	27	5	26	12	25	1	23	16	23	9	22	3	21	23	8
1699	20	18	19	8	20	20	19	7	18	14	16	20	16	5	14	13	12	23	12	12	11	4	10	22	9
1700	9	18	8	13	9	6	7	17	7	6	5	14	4	21	3	5	1	13	1/31	0/10	29	0	28	18	10
1701	27	13	26	7	28	10	26	14	26	3	24	13	23	21	22	6	20	14	19	23	18	10	17	23	11
Differ. in 19 years.	0	15	0	14	0	11	0	8	0	4	0	1	0	1	0	2	0	0	0	3	0	6	0	9	

The Use of this TABLE.

IF you would know on what Day of the Month the Moon Changeth in any Year, look in the Table for the Year of our Lord in the first Column towards the Left-hand, and for the Month in the Head of the Table, and against the Year, and under the Month, you shall have your desire.

Example. I would know upon what Day of *March*, in the Year 1691, it will be New Moon. Look for 1691 in the first Column, and along that Line, under *March*, you shall find 19 Days 8 Hours, which shews, that the Moon will change upon the 19th Day of *March* at 8 a Clock at night, in the Year 1691.—— Again, I desire to know when it will be New Moon in the Month of *September*, in the Year 1698. Find the Year 1698 in the first Column of the Table, and in the same Line, under *September*, you shall find 23 16, which shews that the Moon will change upon the 23 Day, at 16 Hours after 12 at Noon; that is, the 24 Day at 4 in the Morning: And so of any other. For if the Hours be under 12, it is that Day at such an Hour in the Afternoon, or at Night: If the Hours be just 12, the Moon changeth at Midnight; if the Hours be above 12, take 12 from them, and the Remainder will be the time of the Moon's changing the next Day in the Morning, as in the last *Example*. And in this manner you shall find, that the Moon will change in the Month of *June*, in

in the Year 1699, upon the 16th Day, and 20 Hours, from which take 12, and there remains 8 Hours; so that the Moon changeth in the Month of *June*, 1699. upon the 17th Day, at 8 in the Forenoon or Morning; and so of any other Year or Month in the Table.

This Table only shews you the Day and Hour on which the Moon changeth in any Month in any Year; but by it you may find the Day and Hour when it will be Full Moon, or when it enters into any of the Quarters, by help of this Little Table.

To the Time of the New Moon add		D.	H.
For the	First Quart.	7	9
	Full Moon	14	18
	Last Quart.	22	4
From Moon to Moon		29	12

So in the First Example, where in the Year 1691, in the Month of *March*, the Moon changeth upon the 19th Day, at 8 at Night; then 7 Days 9 Hours added thereto, makes 26 Days 17 Hours, which is the 27th Day, at 5 in the Morning; and then the Moon enters into the First Quarter in the Month of *March* 1691.—— Also, in the Year 1698, in the Month of *March*, the Moon changes on the First Day at 8 at Night, to which if you add 7 Days 9 Hours, it makes 8 Days 17 Hours; that is, the 9th Day, 5 in the Morning, at which time the Moon enters into the First Quarter: But if you add to 1 Day 8 Hours, 14 Days 18 Hours, it will make 15 Days 26 Hours; that is, the 16th Day at 2 in the Morning, at which time the Moon will be at Full: And if you add to 1 Day 8 Hours, 22 Days 4 Hours, it will make 23 Days 12 Hours, which is the 24th Day at Midnight, at which time the Moon will enter into the Last Quarter. And lastly, If to 1 Day 8 Hours, you add 29 Days 12 Hours, the Summ will be 31 Days 21 Hours, at which time the Moon will change again that same Month of *March*, in the Year 1698.

SECT. IV. *To find the Age of the Moon.*

TO the Day of the Month in which you desire to know the Moon's Age, add the *Epact* for that Year, (if the time proposed be after the first of *March*; or the *Epact* for the Year before, if the time be in *January* or *February*,) and so many Days more as there are Months from *March* to the Month proposed, (including both Months:) Which three Numbers added together, gives the Age of the Moon, if it be under 30; but if the Summ be above 30, cast away 30, and the Remainder is the Moon's Age.—— This Rule is true when the Month hath 31 Days in it; but if the Month have but 30 Days in it, then from the Summ cast away but 29, and the Remainder will be the Moon's Age.

Example 1. *I desire to know the Age of the Moon upon the Ninth of* May *in the Year* 1691.

1691	The *Epact* for that Year is	11
	The Days of the Month *May*	9
	The Months from *March* to *May*	3
	The Moon is old	23 Days.

Example 2. *Let the Moon's Age be required upon the Eighteenth Day of* June *in the Year* 1700.

1700	The *Epact* for that Year is	20
	The Days of the Month *June* are	18
	The Month from *March* to *June* inclusive	4
	The Summ is	42
	From which subtract 29, (because *June* hath hath but 30 days,)	29
	The Remainder 13 is the Moons Age	13 Days.

The Mon's Age may also be found by *Table* V. For if you look into that Table upon what Day the Moon changed next before the time proposed, count how many Days

Days are contained between the Day of the Change and the Day proposed, and those are the Days of the Moons Age.

By the knowledge of the Moon's Age many necessary Conclusions, useful in *Navigation*, may be performed; as such as follow.

SECT. V. *To find at what Hour the Moon will be South at any time.*

MUltiply the Moon's Age by 4, and divide the Product by 5, the Quotient will give you the Hours, and the Remainder multiplied by 12, the Minutes. This is when the Moon is less than 15 Days old; if she be above 15 Days old, subtract 15 therefrom, and work with the Remainder, as before.

Example. *At what time upon the Ninth of* May, 1691. *will the Moon be upon the Meridian?*

Upon that Day the Moon is 23 Days old, from which take 15, the Remainder is 8, which multiplied by 4, makes 32, which divided by 5, the Quotient is 6 Hours, and the Remainder 2 multiplied by 12, gives 24 Minutes; so that the Moon will be South at 24 min. after 6, upon the Ninth of *May*, 1691.

Note, That if the Moon be less than 15 Days old, she cometh to the Meridian before 12 at Night; if just 15 Days old, just at 12 at Night; if above 15 Days old, after 12 at Night.

SECT. VI. *To know how many Signs and Degrees the Moon is departed from the Sun since her last Conjunction with him.*

MUltiply the Days of the Moon's Age by 2, and the Product divide by 5, the Quotient shall be the Number of Signs; and the Remainder (if any be) every Unite is 6 Degrees.

Example. *Upon the Ninth of* May, 1691, *I desire to know how many Signs the Moon is departed from the Sun since the last Conjunction or New Moon.*

Upon the Ninth of *May*, by the former Directions, I find the Moon is then 23 Days old, which multiplied by 2, (or doubled,) is 46; this divided by 5, gives in the Quotient 9 Signs and 1 remaining, which is 6 Degrees; so that the Moon is departed from the Sun since her last Conjunction with him 9 Signs and 6 Degrees.

SECT. VII. *To find the Time of the Moon's Shining.*

MUltiply the Moon's Age by 48, and divide the Product by 60, the Quotient shall give you the Hours, and the Remainder the Minutes, at the Time of the Moon's Shining.——This is when the Moon is less than 15 Days old: If she above 15 Days old, subtract the time of her Shining found, as before, from 24 Hours, and the Remainder will be the time of her Shining in the Morning.

Example 1. *How long will the Moon shine upon the Eighteenth of* June, 1670?

The Moon that Day is 13 Days old; that multipled by 48, the Product is 624, which divided by 60, the Quotient gives 10 Hours, and the Remainder 24 min. for the time of the Moon's Shining at Night.

Example 2. *How long will the Moon shine upon the Ninth of* May, 1691?

The Moon that Day is 23 Days old, which multiplied by 48, the Product is 1004, and that divided by 60, gives in the Quotient 18 Hours, and 24 min. remaining; which subtracted from 24 Hours, there remains 5 Hours 36 min. for the time of the Moon's Shining in the Morning.

TABLE

TABLE VI.

A TABLE shewing at any Day of the Moon's Age, at what time the Moon cometh to the South:—— The time of her Shining:—— Her Distance from the Sun:— And time of High-water at London-*Bridge.*

Days of the Moon's Age.		*Time of the Moon's coming to South.* H.	M.		*The time of the Moon's Shining.* H.	M.		*The Dist. of the Moon from the Sun.* Sig.	Deg.	*High-water at Lond. Bridg.* H.	M.
From Change to Full	0	12	0	In the Afternoon	0	0	In the Evening	0 ☌	0	3	0
	1	12	48		0	48		0	12	3	48
	2	1	36		1	36		0	24	4	36
	3	2	24		2	24		1	6	5	24
	4	3	12		3	12		1	18	6	12
	5	4	0		4	0		2 ✱	0	7	0
	6	4	48		4	48		2	12	7	48
	7	5	36		5	36		2	24	8	36
	8	6	24		6	24		3 □	6	9	24
	9	7	12		7	12		3	18	10	12
	10	8	0		8	0		4	0	11	0
	11	8	48		8	48		4	12	11	48
	12	9	36		9	36		4	24	12	36
	13	10	24		10	24		5	6	1	24
	14	11	12		11	12		5	18	2	12
	✱ 15	12 ✱	0		12 ✱	0		6 ☍	0	3	0
From Full to Change	16	12	48	In the Morning	11	48	In the Morning	6	12	3	48
	17	1	36		10	36		6	24	4	36
	18	2	24		9	24		7	6	5	24
	19	3	12		8	12		7	18	6	12
	20	4	0		8	0		8	0	7	0
	21	4	48		7	48		8	12	7	48
	22	5	36		6	36		8 □	24	8	36
	23	6	24		5	24		9	6	9	24
	24	7	12		4	12		9	18	10	12
	25	8	0		4	0		10	0	11	0
	26	8	48		3	48		10	12	11	48
	27	9	36		2	36		10	24	12	36
	28	10	24		1	24		11	6	1	24
	29	11	12		12	12		11	18	2	12
	30	12	0		12	0		12 ☌	0	3	0

The Use of this Table.

LOok in the first Column of the Table for the Moon's Age for the Time proposed; and against it, in the Second, Third, Fourth, and Fifth Columns, you shall find such things as are expressed at the top of each Column.

Example. *Upon the Ninth of* May, 1691, *I desire to know the time of the Moon's coming to the South,* &c.

Upon the 9*th.* of *May*, the *Moon* is 23 days old, look for 23 in the first Column, and right against it in the Second you shall find 6 hou. 24 min. at which time the *Moon* will be *South* in the Morning: — In the Third, 5 hou. 24 min. and so long will the *Moon* shine in the Morning. — In the Fourth, 9 Signs 6 Degrees; which shews that the *Moon* is gone so many Signs and Degrees from the *Sun*, since her last Conjunction with him.— In the Fifth, 9 hou. 24 min. at which time it will be High-Water at *London-Bridg.*

Again,

When the *Moon* is 7 days Old she
- will be *South* at 5 h. 36 m. in the Afternoon.
- will shine 5 h. 36 m. in the Evening.
- will be 2 Signs 24 Degrees distant from the *Sun.*
- will make Full Sea, or High-Water at *London-Bridg*, at 8 hours 36 min.

SECT. VIII. *To find the Sign and Degree in which the* Moon *is.*

TABLE VII.

You are to note that the XII *Signs are thus named, charactred, and numbered.*

Names.	Characters.	Number.
Aries	♈	0
Taurus	♉	1
Gemini	♊	2
Cancer	♋	3
Leo	♌	4
Virgo	♍	5
Libra	♎	6
Scorpio	♏	7
Sagittarius	♐	8
Capricorn	♑	9
Aquarius	♒	10
Pisces	♓	11

Note also, That at, or upon the Day of the Change, at that Hour the *Sun* and the *Moon* are both in the same Sign and Degree.

These things premised, you may proceed to find the Place of the *Moon* in the *Zodiack* at any time in this manner.

A Table of the Moon's *Motion in Signs, Degrees, and Minutes, for every Day and Hour of her Age.*

The Days of the *Moon's* Age

Days.	S.	D.	M.
1	0	13	11
2	0	26	21
3	1	9	32
4	1	22	42
5	2	5	53
6	2	19	3
7	3	2	14
8	3	15	25
9	3	28	35
10	4	11	46
11	4	24	56
12	5	8	7
13	5	21	18
14	6	4	28
15	6	17	39
16	7	0	49
17	7	14	0
18	7	27	11
19	8	10	22
20	8	23	32
21	9	0	42
22	9	19	53
23	10	3	3
24	10	16	14
25	10	29	25
26	11	12	35
27	11	29	46
28	0	8	56
29	0	22	27

The Hours of the *Moon's* Age

Hours.	S.	D.	M.
1	0	0	33
2	0	1	6
3	0	1	39
4	0	2	12
5	0	2	45
6	0	3	18
7	0	3	51
8	0	4	24
9	0	4	56
10	0	5	29
11	0	6	2
12	0	6	35
13	0	7	8
14	0	7	41
15	0	8	14
16	0	8	47
17	0	9	20
18	0	9	53
19	0	10	26
20	0	10	59
21	0	11	32
22	0	12	5
23	0	12	38
24	0	13	11

Example.

Example. Let it be required to know in what Sign and Degree of the Zodiack *the* Moon *will be upon the* 31*ſt. Day of* May, *in the Year* 1691.

Firſt look into *Table* V, and ſee there what Day in *May* the *Moon* changed upon, which you will find to be upon tht 17*th* day at 7 at Night; on which day at Noon, by *Table* IV, you will find the *Sun* to be 7 deg. of *Gemini*, and in that *Sign* alſo is the *Moon* at that time; which ſet down as you ſee done in the *Example* following: Then between the 17*th.* Day 7 Hours, to the 31 Day at Noon, are contained 13 Days 17 Hours: Then out of this *Table* VII, take the *Moon's* Mean Motions anſwering to 13 Days and 17 Hours: Theſe three Numbers added together, will give the Signs and Degrees in which the *Moon* is.

The Operation.

	S.	D.	M.
1691. *Sun* and *Moon* in 7 deg of ♊	2	7	00
Moon's Mean Motion for 13 days	5	21	18
Moon's Motion for 17 hours is	0	9	20
The *Moon's* Place	8	7	38

That is, in 7 deg. 38 min. of ♐ *Sagittarius.*

Another Example *of this for the* Moon's *Place upon the* 20*th of.* April 1700.

	S.	D.	M.
The *Moon* Changes in *April* the 7*th.* day, at 17 hours; at which time the *Sun* is in 29 deg. 29 min. of *Aries*: That is ———————	0	29	29
The Difference between 7 days 17 hours and 20 days, is 12 days 7 hours			
The *Moon's* Mean Motion in 12 days	5	08	07
The Mean Motion in 7 hours	0	3	51
The *Moon's* Place	6	11	27

That is, in 11 deg. 27 min. of *Libra.*

But here Note, That if the Number of *Signs* do exceed 12, you muſt ſubtract 12 *Signs*, and the Remainder is the *Sign* in which the *Moon* is.

As in this *Example*, where the *Moon's* Age is 22 days 16 hours, and the *Sun's* Place at the preceding Change in 20 deg. 12 min. ♒.

	S.	D.	M.
Place of the *Sun* on the Change day	10	20	12
The *Moon's* Mean Motion in 22 days	9	19	53
In 16 hours	0	08	47
The Summ	20	18	52
Subtract	12	00	00
Moon's Place	8	18	52

That is, in ♏ 28 deg. 52 min. *Scorpio.*

CHAP. V.

Concerning the Tides.

THE true knowledge of the *Tides* in all places is a matter of great moment: yet nothing more neglected, or ſlightly paſſed over than that is: For the uſual way for finding of the *Tides* is not ſufficiently exact: For there is one onely General Rule uſed, which is true only under the *Poles*, where the *Equinoctial* and *Horizon* are the ſame: And it alſo ſuppoſes, that the departure of the *Moon* from the *Sun* were at all times equal: In both which reſpects the Rule is deficient.

For in the *Latitude* of *London* 51 deg. 30 min. where a *S.W.* or *N. E. Moon* makes a full Sea, and that is at 3 of the Clock; and this is true when the *Moon* is in *Aries* or *Libra*, (or near thereto, and hath no *Latitude*;) but, in the ſame place, the *Moon* being in *Cancer*, and having 5 deg. of *North Latitude*, it will be 30 min. paſt 10 of the Clock before the *Moon* will be *N. E*; which ſhould be at 9 a Clock, by the

vulgar Rule, too late by 1 hour 30 min. And it will be *S. W.* at 30 min. after 1, which is 1 hour 30 min. too soon. And if it be in lesser *Latitude*, as in 20, 30, or 40 deg. the Error will be still greater.

Now to correct this Error, the best way is to reckon the time of high Water by the time of the day, and not by the *Moon's* being upon such a Point of the *Compass*: For the *Table* following shews, that at the New or Full a *S. W. Moon* makes a Full Sea at *London-Bridge*, and that is at 3 of the Clock: It is true, that upon the days of the Full or Change, it is High-Water at *London-Bridg* at 3 of the Clock: But if you should set your *Compass* at 3 of the Clock, you shall not find the *Moon* to be always *S. W.*

As, take a New *Moon* in *June*, and a Full *Moon* in *December*, the *Moon* being then about the *Tropick* of *Cancer*, and you shall find the *Moon* (at *London*) to be *S. W.* at 3 quarters of an hour past One a Clock, and then the *Moon* will be *S S W*, which is two Points farther.

It is to be observed also, That there is a considerable difference between the *Spring* and *Neap-Tides*, in respect of Time: for the *Neap-Tides* will be sometimes an hour or more sooner than the the usual *Tables* and *Instruments* shew them to be.

So the *Moon* being in the first Quarter, the foregoing *Table* VI shews the time of High-Water at *London* to be about 9 of the Clock; but if you observe the time of the *Tide* there, you shall find it to be High-Water before 8 of the Clock: And doubtless the like, or (it may be) greater difference is in other Places also: And therefore to know the true time of the *Tides*, make use of this little *Table* instead of that in the last Column of *Table* VI; wherein some Minutes are subtracted from the Time there found, which will render this *Table* far more exact: it being done by the long Observation and Experience of my loving Friend Mr. *Henry Phillips*, deceased, who lived for many Years upon the same *Bridg*, and made many Experiments about this matter.

TABLE VIII.

A Table, *shewing the time of High-Water at* London-Bridg, *corrected.*

Days of the *Moon's* Age.		High-Water at *London-Bridg.* H.	M.
1	16	3	48
2	17	4	31
3	18	5	14
4	19	5	52
5	20	6	30
6	21	7	3
7	22	7	36
8	23	8	24
9	24	9	27
10	25	10	30
11	26	11	28
12	27	12	26
13	28	1	19
14	29	2	12
15	30	3	0

A Tide-

A Tide-Table, *shewing upon what Point of the* Compass *the* Moon *being, and also at what Hour of the Day it will be Full Sea, upon the Full or Change-Day, in any of these Ports.*

Points of the *Compass* making full Sea.	Names of Places.	Time of Day. H.	M.
S *by* E	*Rye, Wilchelsey, Calshot.*	11	15
S *by* W	*Rochester, Maldon, Black-tail.*	0	45
S S E	*Yarmouth, Dover, Harwich.*	10	30
S S W	*Gravesend, Downs, Blackness, Silly.*	1	30
S E *by* S	*Needles, Orford,* S. *and* N. *Forelands.*	9	45
S W *by* S	*Dundee, S. Andrews, Lisbon, S. Lucas.*	2	15
S E	*Pool, Isle of Man, Dunbar, Diep.*	9	0
S W	*London, Tinmouth, Amsterdam, Rotterdam.*	3	0
S *by* W	*Portland, Hartflew, Dublin.*	8	15
S W *by* W	*Barwick, Flushing, Hamborough.*	3	45
E S E	*Milford, Bridgwater, Land's-End.*	7	30
W S W	*Baltimore, Cork, Seavern, Calice.*	4	30
E *by* S	*Bristol, Start-Point, Waterford.*	6	45
W *by* S	*Falmouth, Humber, New-Castle.*	5	15
W *and* E	*Plimouth, Hull, Lyn, S. Davids.*	6	0
N *and* S	*Queenborough, Southampton, Portsmouth.*	12	0

The Sea hath fits, Alternate Course she keeps,
From Deep to Shoar, and from the Shoar to Deeps:
Whether it were, that at the first the Ocean
From God's own Hand receiv'd this double Motion;
Or, whether Cynthia, *that with Changeful Laws*
Commands moist Bodies, doth this Motion cause.

The End of the first Part.

OF NAVIGATION.

PART II.

OF Plain-Sailing.

WHEREIN

The DOCTRINE of RIGHT-LINED TRIANGLES is applied to PRACTICE, in the Solution of sundry *Nautical Problems* and *Questions* in *Plain-Sailing*.

All which are Performed

I: By *Protraction*, with *Scale* and *Compasses*.

II. By *Trigonometrical Calculation*, either by *Tables* or *Proportional Scales*.

III. Wrought upon the *Chart* it self.

THE *Nautical Problems* which I intend in this Treatise the Solution of, both by *Protraction* and *Trigonometrical Calculation*, shall be such as principally concern *Longitude*, *Latitude*, *Rumb*, (or *Course*,) and *Distance*. Now,

LONGITUDE is the *Distance* of a Place from some known *Meridian*, to that Place; and is always counted upon the *Equinoctial*, from the *North* or *South* towards the *East* or *West*.

LATITUDE is the *Distance* of any Place from the *Equinoctial*, counted upon that *Meridian Circle* which passeth over that Place towards either of the *Poles*, either *North* or *South*; and is so denominated, *North* or *South Latitude*.

RUMB, (or *Course*,) is the *Angle* that a Ship in her Sailing makes with the *Meridian* of the Place in which the Ship is: But the *Complement* of the *Rumb* is the *Angle* that the Ship makes with any *Parallel*.

DISTANCE is the Number of *Leagues*, *Miles*, or *Centesms*, &c. that a Ship hath sailed upon any one *Rumb* or *Course*.

In Sailing,

If your *Rumb* or *Course* be directly *East* or *West*, you alter not your *Latitude* at all. And,

If your *Course* be from the *Equinoctial Northward*, you continually raise the *North-Pole*; or if directly *South*, the *South-Pole*.

The *Raising* of the *Pole* is, when you sail from a *Lesser* to a *Greater Latitude*.

Depressing of the *Pole* is, when you sail from a *Greater Latitude* to a *Lesser*.

For the more easie understanding and resolving the following *Problems*, it will be necessary to know that the *Rumb* or *Course* that a Ship steereth is discovered (in the general) by the *Magnetical Needle*, which always respects the *North*, and (though not directly, yet) its Variation being often observed, and the *Card* or *Compass* rectified thereby, is the best (if not only) Help that *Navigators* yet have to steer their Course by.

PROBLEMS

PROBLEMS in PLAIN-SAILING.

THE *Triangle* which I shall make Use of in the Solution of the Six following *Problems*, shall be the *Triangle* A B C, whose Sides and Angles are as followeth:

Fig. I.

The Side	A B	81.2	Leagues.
	B C	97.5	
	A C	45.3	

		deg.	min.		
The Angle	A	90	00	or, 0	Points from the Meridian.
	B	33	45	3	
	C	56	15	5	

And forasmuch as both in *Plain* and *Mercator*'s Sailing there will be continual Use of Laying down and finding the Quantities of *Lines* and *Angles* already laid down, and how that is to be performed, is supposed already known; but for such as do not, I would have them have recourse to the Three first Sections of the Fifth Book beforegoing, where they shall find ample Satisfaction in that Particular; and so I shall omit to say any thing thereof in this Place, but immediately proceed to Practice.

PROBL. I. *Sailing* 97.5 *Leagues upon the Fifth* Rumb *from the* Meridian, *how much shall I have altered my* Latitude?

I. By *Protraction*.

DRaw a Line at pleasure, as W E, and upon any Point therein, as B, protract an Angle of III Points, (the Complement of V Points, the *Rumb* given,) as the Angle C B A, and upon that Line, by your *Diagonal Scale*, prick down 97.5, (the Leagues sailed from B to C.) Then from the Point C let fall a Perpendicular upon the Line W E, which will fall in A: Then measure the Line C A upon the same *Diagonal Scale*, and you shall find it to contain 54.3 Leagues; and so much have you altered your *Latitude*. *Fig.* I.

II. By *Trigonometry*, *Case* III.

As the *Radius*, 90 deg.	10.
Is to the Leagues sailed, C B, 97.5	1.98900
So is the Co-sine of the *Rumb* B, 33 d. 45 m.	9.74474
To the *Difference* of *Latitude*, C A, 54.3 Leagues	x1.73374

II. *If I sail* 97.5 *Leagues upon the Fifth* Rumb *from the* Meridian, *how far am I departed from the* Meridian *from whence I came?*

I. By *Protraction*.

DRaw a Line at pleasure, as N S, and upon any Point thereof, as C, protract an Angle of Five Points or *Rumbs*, or 56 deg. 15 min. as *a* C *b*, upon which set the *Distance* sailed, 97.5 Leagues from C to B: Then from the Point B let fall a Perpendicular (or take the nearest *Distance*) to the Line N S, as B A, which measured upon your *Scale*, will be found to contain 81.2 Leagues; and so far are you departed from the *Meridian* from whence you came.

II. By *Trigonometry*, *Case* III.

As the *Radius*, 90 deg.	10.
Is to C B, the *Distance* sailed, 97.5 Leagues	1.98900
So is the Sine of the *Rumb*, 56.15 m.	9.91985
To the *Departure* B A, 81.2 Leagues	x1.90885

III. If

III. *If I sail upon the Fifth* Rumb *till I have altered my* Latitude 54.3 *Leagues, how many Leagues have I sailed?*

I. By *Protraction.*

First, draw a line at pleasure, as W E, and upon any Point thereof, as A, erect a Perpendicular, as A N; upon which Line set 54.3, (the Alteration of *Latitude* from A to C:) Then upon the Point C protract an Angle of Five *Rumbs*, or 36 d. 15 m. as *a* C *b*, and draw the Line C *b*, extending it till it cut the Line W E in B; so shall the Line C B be your *Distance* sailed, which measured upon your Scale, will be found to be 97.5 Leagues.

I. By *Trigonometry, Case* II.

As the Co-sine of the Fifth *Rumb*, 33 d. 45 m.	9.74474
Is to C A, the *Difference* of *Latitude*, 54.3 Leagues	1.73480
So is the *Radius*, 90 deg.	10.
To the *Distance* sailed, C B, 97.5 Leagues	1.99006

IV. *If I sail upon the Fifth* Rumb *till I have altered my* Latitude 54.3 *Leagues, how much am I departed from the* Meridian *from whence I came?*

I. By *Protraction.*

Draw a Right Line at pleasure, as W E, and upon any Point therein, (as at A,) erect the Perpendicular A N, and upon it set 54.3 Leagues from A to C: Then upon C protract an Angle of Five *Rumbs*, (or 56 deg. 15 min.) as *a* C *b*, and draw the Line C *b*, extending it till it cut the Line W E in B; so shall the Line A B, measured upon your Scale, be 81.2 Leagues; and so far are you departed from your first *Meridian.*

II. By *Trigonometry, Case* IV.

As the *Radius*, 90 deg.	10.
Is to the *Difference* of *Latitude*, C A, 54.3 Leagues	1.73480
So is the *Tangent* of the Fifth *Rumb*, 56 d. 15 m.	10.17511
To the *Departure* A B, 81.2 Leagues	x1.90991

V. *Sailing upon some* Rumb *between the South and West,* 97.5 *Leagues, and then finding that I have altered my* Latitude 54.3 *Leagues, I would know upon what* Rumb *I have steered.*

I. By *Protraction.*

Draw a Right Line at pleasure, as W E, and upon any Point thereof, as A, erect the Perpendicular A N, and upon it set 54.3 Leagues, the Alteration of *Latitude*, from A to C: Then take in your Compasses, from your Scale, 97.5, the Leagues sailed, and with that *Distance*, setting one Foot in C, with the other describe the small Arch *c d*, cutting the Line W E in B. This done, by your *Scale* of *Chords* or *Protractor* seek the Quantity of the *Angle* A C B, which you shall find to contain 56 d. 15 m. or Five Points from the *Meridian, viz.* S W by W; and upon that *Rumb* have you steered.

II. By *Trigonometry, Case* V.

As the *Distance* sailed, C B, 97.5 Leagues	1.98900
Is to the *Difference* of *Latitude*, C A, 54.3 Leagues	11.73480
So is the *Radius*	10.
To the Co-sine of the *Rumb*, 33 d. 45 m.	9.74580

VI. *If*

VI. *If I Sail upon some* Rumb *between the South and the* West *97.5 Leagues, and then finding that I have parted from my first* Meridian 81.2 *Leagues; I demand how much I have alter'd my* Latitude.

I. By *Protraction.*

First draw a Right Line W E, and upon any Point therein, as at A, erect a Perpendicular A N: Then take 81.2 Leagues, your departure from your first *Meridian*, and set them from A to B: Then, for that you have sailed 97.5 Leagues, take 97.5 out of your Scale, and setting one Foot in B, with the other describe the small Arch *e f* crossing the Perpendicular A N in C. Lastly, draw the Line C B, so shall you include two Angles, *viz.* A C B, containing Five *Rumbs*, or 56 deg. 15 min. and the other A B C three *Rumbs*, or 33 deg. 45 min. and the Line C A, measured upon your Scale, will be found to be 54.3 Leagues; and so much have you alter'd your *Latitude.*

II. By *Trigonometry*, *Case* VII.

(1.) As the Distance sailed C B, 97.5 Leagues,	1.98900
Is to your Departure A B, 81.2 Leagues,	11.90955
So is the *Radius*, 90 deg.	10.
To the Sine of the Angle at C, 56 deg. 15 min.	9.92055
(2.) As *Radius*, 90 deg.	10.
Is to B C the Distance sailed, 97.5 Leagues,	1.98900
So is the Sine of the Angle at B, 33 deg. 45 min.	9.74474
To the alteration of *Latitude* C A, 54.3 Leagues,	x1.73374

These *Problems* might be enlarged, but these are sufficient in this Place, and therefore I will proceed to the Protracting and Calculating of a *Traverse.*

Of a TRAVERSE.

A *Traverse* is the variation or alteration of the Ship's Course or Way, upon the shifting of the Wind, or other interruptions of Rocks, Sands, or the like.

VII. *A Ship sails from the* North *towards the* West, *upon these following Points of the Compass*, viz.

	Leagues.	Points.
1. South East *by* East, half a Point Easterly	5	V½
2. East South East	4	VI
3. East *by* South	7	VII
4. East, half a Point Northerly	3	VII½
The Wind Changing she steers		
5. South South West	5	II
6. South *by* West	6	I
7. South	4	o
8. South South East	7	II
9. South East *by* South	2	III

I demand, (1.) How much I am departed from my first *Meridian.* (2.) The Difference of *Latitude.* (3.) The Distance of the two Places upon the *Rumb.* (4.) The Bearing of the one Place from the other.

I. By *Protraction.*

Upon a Sheet of Paper or fine Paist-board, draw a Right-Line N S for your *Meridian*, and another at Right-Angles thereunto, as E W, for your Parallel: and let A, the *Fig.* II.

A, the Point of Intersection of these two Lines, represent the Place from whence you set Sail. Then,

1. The first Course being S E *by* E, ½ a Point Easterly, that is 5½ Points, or 61 deg. 52 min. from the *Meridian*, I Protract an Angle of that quantity, as the Angle *b* A *c*, and upon the Line A *b* I set my first distance sailed from A to B, five Leagues.

2. Through the Point B, draw a Line B *d*, parallel to the *Meridian* N S; and upon B, Protract an Angle of Six Points, or 67 deg. 30 min. *i. e.* E S E, as the Angle *e* B *d*, and draw the Line B *e*, setting thereupon 4 Leagues, your Second Distance sailed from to C.

3. Through the Point C, draw a Line C *f*, parallel to the *Meridian* N S; and upon C Protract an Angle of Seven Points, *viz.* E *by* S, or 78 deg. 45 min. as *g* C *f*, and draw the Line C *g*, setting thereupon your Third distance sailed, *viz.* 7 Leagues from C to D.

4. Through the Point D, draw a Line D *h*, parallel to the *Meridian* N S; and upon D Protract an Angle of 7½ Points, (*i. e. East* ½ a Point *Northerly*) your fourth Course, or 81 deg. 33 min. and draw the Line D *k*; upon which set 3 Leagues (your fourth distance sailed) from D to E.

The Wind now shifting *Northerly*.

5. Through the Point E, draw a Line E *l*, parallel to N S, and upon E Protract an Angle *l* E *m*, equal to your fifth Course S S W, or two Points, or 22 deg. 30 min. and draw the Line E *m*; upon which set 5 Leagues, your fifth distance sailed from E to F.

6. Through the Point F, draw the Line F *n*, parallel to the *Meridian* Line N S, and upon F Protract an Angle *n* F *o*, equal to your sixth Course S *by* W, one Point, or 11 deg. 15 min. and draw the Line F G, setting thereon your sixth distance sailed, *viz.* 6 Leagues from F to G.

7. Your seventh Course being directly *South* through G, draw a Line parallel to N S, and upon it set your seventh Course sailed, *viz.* 4 Leagues from G to H.

8. Through H draw a Line H *q*, parallel to N S, and upon H Protract an Angle *p* H *q* equal to your eight Course S S E, two Points, or 22 deg. 30 min. and draw the Line H *p*; upon which set your eighth distance sailed 7 Leagues from H to K.

9. Through K draw a Line K *s*, parallel to the *Meridian* N S, and upon the Point K Protract an Angle *v* K *s*, equal to your ninth Course S E *by* S, or three Points, or 33 deg. 45 min. and draw the Line K *v*; upon which set your ninth distance sailed from K to L, three Leagues; and so have you finished your *Traverse*.

The *Traverse* being thus finished, you may find,

1. The Departure from the first *Meridian* A P, to be 28.43 Leagues.
2. The Difference of *Latitude* P L, to be 18.62 Leagues.
3. The Distance of the two Places upon the *Rumb* A L, to be 34.00 Leagues.
4. The Bearing of the one Place from the other L A P, to be S E *by* S. *ferè*.

II. By *Trigonometry*.

(1.) In the First Course for the difference of *Latitude*.

As the *Radius*, Sine of 90 deg.	10.
Is to the distance sailed A B, 5.00 Leagues,	0.69897
So is the Co-Sine of the *Rumb* *b* A *c*, 61 deg. 52 min.	9.67350
To the difference of *Latitude* M A, 4.41.	10.64436

(2.) In the First Course for the departure.

As *Radius*, 90 deg.	10.
Is to the distance sailed A B, 5.00 Leagues,	0.69897
So is the Sine of the *Rumb* *b* M A B, 28 deg. 8 min.	9.67350
To the departure A O, 2.36 Leagues,	10.37247

And thus must you Work with all the other Courses and Distances, and collect them into a *Table*, as here following:

Courses

Courses	Numb. of Points.	Distance Run.	North.	South.	East.	West.
S E *by* E $\frac{1}{2}$ East	$5\frac{1}{2}$	5 . 03		2 36	4 41	
E S E	6	4 . 00		1 53	3 70	
E *by* S	7	7 . 00		1 37	6 86	
East $\frac{1}{2}$ North	$7\frac{1}{2}$	3 . 00	0 29		2 98	
S S W	2	5 . 00		4 62		1 19
S *by* W	1	6 . 00		5 88		1 17
South	0	4 . 00		4 00		0 00
S S E	2	7 . 00		6 47	2 08	
S E *by* S	3	3 . 00		2 49	1 67	
The Summs			0 29	28 72	21 . 70	3 08
				0 29	3 08	
			Departure.	28 . 43	18 . 62	Dif.Lat.

This *Table* you see consists of Seven Columns: the First contains the Courses or Points of the *Compass* you Steer upon.— The Second shews how many Points and Parts of a Point are contained between it and the *Meridian*.— The Third contains the Number of Leagues, Miles, *&c.* sailed.— The Four other Columns contains the *Northing*, *Southing*, *Easting*, or *Westing* of any Course.

Your *Table* being thus prepared, You see that in your *Traverse*, the First Course steered was S E *by* E $\frac{1}{2}$ a Point *Easterly*; which I set down in the First Column of the *Table*.— And because it is $5\frac{1}{2}$ Points from the *Meridian*, set $5\frac{1}{2}$ in the Second Column.— And because upon that Course, the distance run was 5.00 Leagues, I set them in the Third Column.— And then finding by my *Trigonometrical Calculation*, that my difference of *Latitude* was *Easterly* 4.41 Leagues, I set 4.41 in the Column under *East*: And my departure being 2.36 Leagues *Southward*, I set 2.36 in the Column under *South*.

Then for the Second Course, it being E S E (or 6 Points) and the distance sailed 4.00 Leagues, I set them down in the Three first Columns: and for the difference of *Latitude* and departure, I go again to my *Trigonometrical* Work: Saying,

(1.) For the Difference of *Latitude*.

As *Radius*, 90 deg.	10.
Is to the Co-Sine of the *Rhumb e* B *d*, 67 deg. 30 min.	9.96562
So is the Distance sailed B C, 4.00 Leagues,	0.60206
To the Difference of *Latitude*, 3.70 Leagues,	10.56768

Which I set in the *East* Column: And say,

(2.) For the Departure.

As *Radius*, 90 deg.	10.
Is to the distance sailed B C, 4.00 Leagues,	0.60206
So is the Sine of the *Rhumb*, 22 deg. 30 min.	9.58284
To the Departure, 1.53 Leagues,	10.18490

Which must be set in the Column under *South*.

And proceeding in this manner with all your Courses and Distances, collect them into a *Table*, and you shall find them as in the *Table* before is exhibited.

This done, add the Leagues in every Column together, and set their Summs at the bottom: Then compare the *North* and *South* Columns together, as 0.29 Leagues, and 28.72 Leagues, Subtract the lesser from the greater, and the Remainder is the Departure, and is here 28.43 Leagues for A P.— Also compare the *East* and *West* Columns together, and they are 21.70 Leagues, and 3.08 Leagues, the lesser subtracted from the greater, leaves 18.62 Leagues for the difference of *Latitude*.

Then

Then for the *Rhumb* leading from the First Place to the Second, *viz.* from A to L, say,

By *Case* VI of *Plain Triangles.*

As A P (the Departure from the first *Meridian*,) 28.43 Leagues,	1.45377
Is to *Radius*, *Tangent* 45 deg.	10.
So is L P (the Difference of *Latitude*;) 18.62 Leagues,	11.26997
To the *Tangent* of the *Rhumb* L A P, 33 deg. 13 min. That is S E *by* S *fere.*	9.81620

And for the Distance A L,

As the Sine of the *Rhumb* L A B, 33 deg. 13 min.	9.73863
Is to the Difference of *Latitude* L P, 18.62 Leagues,	1.26997
So is *Radius* 90 deg.	10.
To the Distance upon the *Rhumb* A L, 34.00 Leagues,	1.53134

How to work a Traverse, *by help of the* Table *following, without* Trigonometrical *Calculation.*

VIII. *A Ship being in* 47 *deg.* 30 *min. of* North Latitude, *and counting her to be in* 00 *deg.* (*or the beginning*) *of* Longitude, *Sails*

	Leagues.	Points.
South East *by* South	16	III
South South West	13	II
East *by* North	18	VII
North *by* East, half a Point Easterly,	16	I½
North North west, half a Point Westerly,	15	II½
West North West	18	VI
South East *by* South	18	III
South South West	15	II
South West *by* South	12	III
West South West	18	VI
East South East	18	VI

And it is required to find the Latitude *the Ship is in, and the Departure from the* Meridian, *or Difference of* Longitude.

HAving prepared a blank *Table*, and divided it into Seven Columns, as in the former *Traverse*, and set down in the First Column the several Courses you have sailed upon; in the Second, the Distance you have sailed; in the Third, the Number of Points from the *Meridian*; and in the Four last, the *Easting*, *Westing*, *Northing*, and *Southing*, as you see here done.

Courses sailed.	Leagues	Points *à Mer.*	North.	South.	East.	West.
S E *by* S	16	III		13.30	08.89	
S S W	13	II		12.01		04.97
E *by* N	18	VII	03.51		17.65	
N *by* E ½ East	16	I½	15.31		04.64	
N N W ½ W	15	II½	13.23			07.07
W N W	18	VI	06.89			16.63
S E *by* S	18	III		14.97	10.00	
S S W	15	II		13.86		05.74
S W *by* S	12	III		09.98		06.67
W S W	18	VI		06.89		16.63
E S E	18	VI		06.89	16.63	
Summs of the Four last Col.			3.894	77.90	57.81	57.71
Subtract				38.94	57.71	
Rem. Difference of *Latitude.*				38.96	00.10	Depart.

Your

Your *Table* being thus prepared, you must have recourse to the following *Traverse Table*; and seeing that your first Course was S E *by* S, that is III Points from the *Meridian*, and the Leagues sailed were 16: Look for 3 Points in the Head of the *Table*, and under it, against 16, you shall find 13.30 Leagues for the *Southing*, and 08.89 Leagues for the *Easting*; which set under the *South* and *East* Columns, for that the Course was *South-Easterly*: And thus must you doe with all the rest of the Courses. As for the Fourth Course, which is N *by* E, half a Point *Easterly*; that is, 1 Point and a half from the *Meridian*; find $1\frac{1}{2}$ Point in the Head of the *Table*, and 18 Leagues in the first Column to the Left-hand, and against it you shall find 15.31 Leagues, for the *Northing*, and 04.64 Leagues for the *Easting*; which set in the *North* and *East* Columns, because the Course was *North-Easterly*: and so of the rest; only, if your Number of Points be above IV from the *Meridian*, you must then find the Number of Points in the bottom of the *Table*, and the distance Sailed in the first or last Column of the *Table*, and in the common Meeting you shall find the *Easting*, *Westing*, *Northing*, and *Southing*, as before: As in the Sixth Course, which is W N W; that is, VI Points from the *Meridian*; find 6 Points in the Foot of the *Table*, and 18 the Leagues Sailed in the first or last Column, and in the Angle of Meeting you shall have 06.89 Leagues for your *Northing*, and 16.63 Leagues for your *Westing*; which set down in the *North* and *West* Columns. And when you have thus done with all your Courses and Distances, add up every Column severally, and subtract the Lesser *Northing* or *Southing* from the Greater, and the Remainder shall give you the difference of *Latitude*, in this *Example*, 38.96 Leagues: And the Lesser *Easting* or *Westing*, subtracted from the Greater, shall give you the Departure, which is only 00.10 Parts of a League; which shews the Course to be *South* 00.10 Parts of a League *Easterly*. And let these two *Examples* suffice for Traversing both by *Protraction*, *Calculation*, and by the *Traverse Table* following.

A
TRAVERSE TABLE,
TO
Every Point, Half Point, and Quarter Point,
OF THE
COMPASS:
GIVING
The Difference of *Longitude*, and Departure from the *Meridian* in Leagues or Miles, and Hundred Parts of the same, without *Trigonometrical Calculation*.

The TRAVERSE TABLE.

Leagues or Miles failed.	0 Deg. 49 M.		5 Deg. 37 M.		8 Deg. 26 M.		11 Deg. 15 M.		Leagues or Miles failed.
	0 Point. 1 Quar.		0 Point. 2 Quar.		0 Point. 3 Quar		1 Point.		
	N. S.	E. W.	N. S.	E. W.	N. S.	E. W.	N. S.	E. W.	
1	01 00	00 05	01 00	00 10	00 98	00 14	00 98	00 20	1
2	02 00	00 10	01 99	00 20	01 97	00 29	01 96	00 39	2
3	03 00	00 15	02 98	00 29	02 96	00 44	02 94	00 58	3
4	04 00	00 20	03 98	00 39	02 95	00 58	03 92	00 78	4
5	04 09	00 25	04 97	00 49	04 94	00 73	04 90	00 98	5
6	05 09	00 29	05 97	00 59	05 93	00 88	05 88	01 17	6
7	06 09	00 34	06 97	00 69	06 92	01 02	06 86	01 37	7
8	07 09	00 39	07 96	00 78	07 91	01 17	07 85	01 56	8
9	08 09	00 44	08 96	00 88	08 90	01 32	08 83	01 76	9
10	09 09	00 49	09 95	00 98	09 89	01 46	09 81	01 95	10
11	10 98	00 54	10 95	01 08	10 88	01 61	10 79	02 15	11
12	11 98	00 59	11 94	01 18	11 07	01 76	11 77	02 34	12
13	12 98	00 63	12 94	01 27	12 86	01 91	12 75	02 54	13
14	13 98	00 68	13 93	01 37	13 85	02 05	13 73	02 37	14
15	14 98	00 73	14 93	01 47	14 84	02 20	14 71	02 19	15
16	15 98	00 78	15 92	01 57	15 83	02 34	15 69	03 12	16
17	16 98	00 83	16 92	01 67	16 82	02 49	16 67	03 32	17
18	17 97	00 88	17 91	01 76	17 80	02 64	17 65	03 51	18
19	18 97	00 93	18 91	01 86	18 79	02 79	18 64	03 71	19
20	19 97	00 98	19 90	01 96	19 78	02 93	19 62	03 90	20
21	20 97	01 03	20 90	02 06	20 77	03 08	20 60	04 10	21
22	21 97	01 08	21 89	02 16	21 76	03 22	21 58	04 29	22
23	22 97	01 13	22 89	02 25	22 75	03 37	22 56	04 49	23
24	23 97	01 17	23 88	02 35	23 74	03 52	23 54	04 68	24
25	24 97	01 22	24 88	02 45	24 73	03 66	24 52	04 88	25
26	25 96	01 27	25 87	02 55	25 71	03 81	25 50	05 07	26
27	26 96	01 32	26 87	02 65	26 70	03 96	26 48	05 27	27
28	27 96	01 36	27 86	02 75	27 69	04 10	27 46	05 46	28
29	28 96	01 42	28 86	02 84	28 68	04 25	28 44	05 66	29
30	29 96	01 47	29 86	02 94	29 67	04 40	29 42	05 85	30
31	30 96	01 52	30 85	03 04	30 66	04 55	30 40	06 05	31
32	31 96	01 57	31 85	03 14	31 65	04 69	31 38	06 24	32
33	32 96	01 61	32 85	03 23	32 64	04 84	32 37	06 44	33
34	33 95	01 66	33 84	03 33	33 63	04 98	33 35	06 53	34
35	34 95	01 71	34 83	03 43	34 62	05 13	34 33	06 83	35
36	35 95	01 75	35 83	03 53	35 61	05 28	35 31	07 02	36
37	36 95	01 81	36 82	03 63	36 60	05 42	36 29	07 22	37
38	37 95	01 86	37 82	03 73	37 59	05 57	37 27	07 41	38
39	38 95	01 91	38 81	03 82	38 58	05 72	38 25	07 61	39
40	39 95	01 96	39 81	03 92	39 57	05 87	39 23	07 80	40
41	40 95	02 01	40 80	04 02	40 55	06 02	40 21	08 00	41
42	41 95	02 06	41 80	04 12	41 54	06 16	41 19	08 19	42
43	42 95	02 11	42 79	04 21	42 53	06 31	42 17	08 39	43
44	43 94	02 15	43 79	04 31	43 52	06 45	43 15	08 58	44
45	44 94	02 20	44 78	04 41	44 51	06 60	44 14	08 78	45
46	45 94	02 25	45 78	04 51	45 50	06 75	45 12	08 77	46
47	46 94	02 30	46 77	04 61	46 49	06 89	46 10	09 17	47
48	47 94	02 35	47 77	04 70	47 48	07 04	47 08	09 36	48
49	48 94	02 40	48 76	04 80	48 47	07 20	48 06	09 56	49
50	49 94	02 45	49 76	04 90	49 46	07 33	49 04	09 75	50
60	59 92	02 94	59 71	05 88	59 35	08 80	58 85	11 70	60
70	69 91	03 43	69 66	06 86	69 24	10 27	68 65	13 65	70
80	79 90	03 92	79 61	07 84	79 13	11 73	78 46	15 60	80
90	89 89	04 41	89 56	08 82	89 02	13 20	88 27	17 55	90
100	99 87	04 90	99 51	09 80	98 91	14 67	98 08	19 50	100
200	199 76	09 80	199 02	19 90	197 82	29 34	196 16	39 00	200
	E. W.	N. S.	E. W.	N. S.	E. W.	N. S.	E. W.	N. S.	
	7 Points 3 Quar		7 Points 2 Quar		7 Points 1 Quar		7 Points.		
	87 Deg. 11 M.		84 Deg. 22 M.		81 Deg. 34 M.		78 Deg. 45 M		

The TRAVERSE TABLE.

Leagues or Miles failed.	14 Deg. 04 M.		16 Deg. 52 M.		19 Deg. 41 M.		22 Deg. 30 M.		Leagues or Miles failed.
	1 Point. 1 Quar.		1 Point 2 Quar.		1 Point 3 Quar		2 Points		
	N. S.	E. W.	N. S.	E. W.	N. S	E. W.	N. S	E. W.	
1	00 97	00 24	00 96	00 29	00 94	00 33	00 92	00 38	1
2	01 94	00 48	01 91	00 58	01 88	00 67	01 85	00 76	2
3	02 91	00 72	02 87	00 87	02 82	01 01	02 77	01 75	3
4	03 88	00 97	03 83	01 16	03 77	01 34	03 70	01 53	4
5	04 85	01 21	04 78	01 45	04 71	01 68	04 62	01 91	5
6	05 82	01 45	05 74	01 74	05 65	02 02	05 54	02 30	6
7	06 79	01 70	06 70	02 03	06 59	02 35	06 47	02 69	7
8	07 76	01 94	07 66	02 32	07 53	02 70	07 39	03 16	8
9	08 73	02 18	08 61	02 61	08 47	03 03	08 31	03 44	9
10	09 70	02 43	09 57	02 90	09 41	03 37	09 20	03 83	10
11	10 67	02 67	10 53	03 19	10 36	03 71	10 16	04 21	11
12	11 64	02 91	11 48	03 48	11 30	04 04	11 09	04 59	12
13	12 61	03 15	12 44	03 79	12 24	04 36	12 01	04 97	13
14	13 58	03 40	13 40	04 06	13 18	04 72	12 93	05 36	14
15	14 55	03 64	14 35	04 35	14 12	05 05	13 36	05 74	15
16	15 52	03 88	15 31	04 64	15 06	05 39	14 78	06 12	16
17	16 49	04 13	16 27	04 93	16 00	05 73	15 71	06 51	17
18	17 46	04 37	17 22	05 22	16 95	06 06	16 53	06 89	18
19	18 43	04 61	18 18	05 51	17 89	06 40	17 55	07 27	19
20	19 40	04 86	19 14	05 81	18 83	06 74	18 48	07 65	20
21	20 37	05 10	20 10	06 10	19 77	07 08	19 40	08 04	21
22	21 34	05 34	21 05	06 39	20 71	07 41	20 32	08 42	22
23	22 31	05 48	22 01	06 68	21 66	07 75	21 25	08 80	23
24	23 28	05 83	22 97	06 97	22 60	08 08	22 17	09 18	24
25	24 25	06 07	23 91	07 26	23 54	08 42	23 10	09 57	25
26	25 22	06 31	24 88	07 55	24 48	08 76	24 02	09 95	26
27	26 19	06 56	25 84	07 84	25 46	09 10	24 94	10 33	27
28	27 16	06 80	26 79	08 13	26 36	09 43	25 87	10 71	28
29	28 13	07 04	27 75	08 42	27 30	09 77	26 79	11 10	29
30	29 10	07 28	28 71	08 71	28 25	10 11	27 72	11 48	30
31	30 07	07 53	29 66	09 00	29 19	10 44	28 64	11 86	31
32	31 04	07 77	30 62	09 29	30 13	10 74	29 56	12 25	32
33	32 01	08 01	31 58	09 58	31 07	11 12	30 49	12 63	33
34	32 98	08 26	32 54	09 87	32 01	11 45	31 44	13 01	34
35	33 95	08 50	33 49	10 16	32 95	11 79	32 34	13 39	35
36	34 92	08 74	34 45	10 45	33 89	12 13	33 26	13 78	36
37	35 89	08 99	35 41	10 74	34 84	12 47	34 18	14 16	37
38	36 86	09 23	36 36	11 03	35 78	12 80	35 11	14 54	38
39	37 83	09 47	37 32	11 32	36 72	13 14	36 03	14 92	39
40	38 80	09 71	38 28	11 61	37 66	13 48	36 96	15 31	40
41	39 77	09 96	39 23	11 90	38 60	13 81	37 88	15 69	41
42	40 74	10 20	40 19	12 19	39 54	14 15	38 80	16 07	42
43	41 71	10 44	41 15	12 45	40 49	14 49	39 73	16 45	43
44	42 68	10 69	42 12	12 77	41 43	14 72	40 65	16 84	44
45	43 65	10 83	43 9	13 06	42 37	15 16	41 57	17 22	45
46	44 62	11 17	44 02	13 35	43 31	15 50	42 50	17 60	46
47	45 59	11 42	44 98	13 64	44 25	15 83	43 42	17 99	47
48	46 56	11 66	45 93	13 93	45 19	16 17	44 35	18 37	48
49	47 53	11 90	46 89	14 22	46 13	16 37	45 27	18 75	49
50	48 50	12 14	47 85	14 51	47 08	16 85	46 19	19 13	50
60	58 20	14 57	57 42	17 42	56 49	20 21	55 43	22 58	60
70	67 90	17 00	66 90	20 31	65 90	23 58	64 67	26 78	70
80	77 60	19 43	76 55	23 22	75 32	25 95	73 91	30 61	80
90	87 30	21 80	86 10	26 12	84 73	30 39	83 14	34 44	90
100	97 00	24 29	95 69	29 02	94 15	33 68	92 38	38 36	100
200	194 00	48 58	191 38	58 04	188 30	67 36	184 76	76 52	200
	E. W.	N. S.	E. W.	N. S.	E. W.	N. S.	E. W	N. S.	
	6 Points 3 Quar.		6 Points 2 Quar.		6 Points 1 Quar.		6 Points.		
	75 Deg. 56 M.		73 Deg. 07 M.		70 Deg. 1 M.		67 Deg. 30 M.		

The TRAVERSE TABLE.

Leagues or Miles failed.	25 Deg. 19 M.		28 Deg. 07 M.		30 Deg. 56 M.		33 Deg. 45 M.		Leagues or Miles failed.
	2 Points	1 Quar.	2 Points	2 Quar.	2 Point	3 Quar.	3 Points		
	N. S.	E. W.	N. S.	E. W.	N. S	E. W	N. S	E. W.	
1	00 90	00 43	00 88	00 47	00 86	00 51	00 33	00 56	1
2	01 81	00 85	01 76	00 94	01 71	01 03	01 66	01 55	2
3	02 71	01 28	02 65	01 44	02 57	01 54	02 49	01 67	3
4	03 61	01 71	03 53	01 89	03 43	02 06	03 32	02 22	4
5	04 52	02 14	04 41	02 36	04 29	02 57	04 16	02 78	5
6	05 42	02 56	05 29	02 83	05 15	03 08	04 99	03 33	6
7	06 33	02 99	06 17	03 30	06 00	03 60	05 82	03 89	7
8	07 23	03 42	07 05	03 77	06 86	04 11	06 65	04 44	8
9	08 14	03 85	07 94	04 24	07 72	04 63	07 48	05 00	9
10	09 04	04 28	08 82	04 71	08 58	05 14	08 31	05 55	10
11	09 94	04 70	09 70	05 18	09 44	05 66	09 15	06 11	11
12	10 85	05 13	10 58	05 66	10 29	06 17	09 98	06 67	12
13	11 75	05 56	11 46	06 13	11 15	06 68	10 81	07 22	13
14	12 66	05 99	12 35	06 60	12 00	07 20	11 64	07 78	14
15	13 56	06 41	13 23	07 07	12 87	07 71	12 47	08 33	15
16	14 46	06 84	14 11	07 54	13 72	08 23	13 30	08 89	16
17	15 37	07 27	14 99	07 01	14 54	08 74	14 13	09 44	17
18	16 27	07 70	15 87	08 48	15 44	09 25	14 97	10 00	18
19	17 18	08 12	16 76	08 96	16 30	09 77	15 80	16 56	19
20	18 8	08 55	17 64	09 43	17 16	10 28	16 62	11 11	20
21	18 98	08 98	18 52	09 90	18 01	10 80	17 46	11 67	21
22	19 89	09 41	19 40	10 37	18 87	11 31	18 29	12 22	22
23	20 79	09 83	20 28	10 84	19 73	11 32	19 12	12 78	23
24	21 60	10 26	21 17	11 31	20 59	12 34	19 95	13 33	24
25	22 60	10 69	22 05	11 78	21 44	12 35	20 79	13 89	25
26	23 50	11 12	22 93	12 26	22 30	13 57	21 62	14 44	26
27	24 41	11 54	23 81	12 73	23 16	13 88	22 45	15 15	27
28	25 31	11 97	24 69	13 20	24 02	14 39	23 28	15 56	28
29	26 22	12 48	25 58	13 67	24 87	14 91	24 11	16 11	29
30	27 12	12 83	26 46	14 14	25 73	15 42	24 94	16 67	30
31	28 02	13 25	27 34	14 61	26 59	15 94	25 78	17 22	31
32	28 93	13 68	28 22	15 08	27 45	16 45	26 61	17 78	32
33	29 83	14 11	29 10	15 56	28 31	16 97	27 44	18 33	33
34	30 74	14 54	29 98	16 03	29 16	17 48	28 27	18 89	34
35	31 64	14 96	30 87	16 50	30 02	17 99	29 10	19 44	35
36	32 54	15 39	31 75	17 97	30 88	18 51	29 93	20 00	36
37	33 45	15 82	32 63	17 44	31 74	19 02	30 76	20 56	37
38	34 35	16 25	33 57	17 91	32 59	19 54	31 60	21 11	38
39	35 26	16 68	34 40	18 38	33 45	20 05	32 43	21 57	39
40	36 16	17 10	35 28	18 86	34 31	20 56	33 26	22 22	40
41	37 06	17 53	36 16	19 34	35 17	21 08	34 09	22 78	41
42	37 97	17 96	37 04	19 81	36 02	21 59	34 92	23 34	42
43	38 87	18 38	37 92	20 27	36 88	22 11	35 75	23 89	43
44	39 78	18 81	38 86	20 74	37 74	22 62	36 58	24 44	44
45	40 68	19 24	39 69	21 21	38 60	23 14	37 42	25 00	45
46	41 51	19 67	40 57	21 68	39 46	23 65	38 95	25 50	46
47	42 49	20 09	41 41	22 16	40 31	24 16	39 08	26 1[illegible]	47
48	43 39	20 52	42 33	22 63	41 17	24 68	39 91	26 57	48
49	44 30	20 95	43 21	23 10	42 03	25 19	40 74	27 22	49
50	45 20	21 48	44 10	23 57	43 89	25 71	41 57	27 78	50
60	54 24	25 65	52 91	28 28	51 46	30 84	49 89	33 33	60
70	63 27	29 92	61 73	32 99	60 04	35 98	58 22	38 88	70
80	72 31	34 20	70 55	37 71	68 61	41 12	66 5[illegible]	44 44	80
90	81 35	38 47	79 37	42 43	77 19	46 26	74 8[illegible]	50 00	90
100	90 39	42 75	88 19	47 13	85 77	51 41	83 14	55 55	100
200	180 78	85 50	176 38	94 26	171 54	102 82	166 28	111 10	200
	E. W	N. S.	E. W.	N. S.	E. W.	N. S.	E. W	N. S.	
	5 Points	3 Quar.	5 Points	2 Quar.	5 Points	1 Quar.	5 Points.		
	64 Deg. 42 M.								

The TRAVERSE TABLE.

Leagues or Miles sailed.	36 Deg. 34 M.		39 Deg. 22 M.		42 Deg. 11 M.		45 Deg. 00 M.		Leagues or Miles sailed.
	3 Points 1 Quar.		3 Points 2 Quar.		3 Points 3 Quar.		4 Points		
	N. S.	E. W.	N. S.	E. W.	N. S.	E. W.	N. S.	E. W.	
1	01 80	00 60	00 77	00 63	00 74	00 67	00 71	00 71	1
2	02 61	01 19	01 55	01 27	01 48	01 34	01 41	01 41	2
3	03 41	01 41	02 32	01 90	02 22	02 01	02 12	02 12	3
4	04 21	02 38	03 09	02 54	02 96	02 69	02 83	02 83	4
5	04 02	02 98	03 86	03 17	03 70	03 36	03 54	03 54	5
6	04 82	03 57	04 64	03 81	04 44	04 03	04 24	04 24	6
7	05 62	04 17	05 41	04 44	05 18	04 78	04 55	04 55	7
8	06 43	04 76	06 18	05 07	05 93	05 37	05 66	05 66	8
9	07 23	05 36	07 96	05 71	06 67	06 04	06 36	06 36	9
10	08 03	05 96	07 73	06 94	07 41	06 72	07 07	07 07	10
11	08 83	06 55	08 50	06 98	08 15	07 39	07 78	07 78	11
12	09 64	07 15	09 28	07 61	08 89	08 06	08 49	08 49	12
13	10 44	07 74	10 05	08 25	09 63	08 73	09 19	09 19	13
14	11 24	08 34	10 82	08 80	10 37	09 40	09 90	09 90	14
15	12 05	08 94	11 60	09 52	11 11	10 07	10 61	10 61	15
16	12 85	09 53	12 37	10 15	11 85	10 74	11 31	11 31	16
17	13 66	10 13	13 14	10 78	12 70	11 42	12 02	12 02	17
18	14 46	10 72	13 91	11 42	13 34	12 09	12 73	12 73	18
19	15 26	11 32	14 69	12 04	14 08	12 76	13 44	13 44	19
20	16 06	11 91	15 46	12 69	14 82	13 43	14 14	14 14	20
21	16 87	12 51	16 23	13 32	15 56	14 10	14 85	14 85	21
22	17 67	13 11	17 01	13 96	16 30	14 77	15 56	15 56	22
23	18 47	13 70	17 78	14 59	17 04	15 45	16 26	16 26	23
24	19 28	14 30	18 55	15 22	17 78	16 12	16 97	16 97	24
25	20 08	14 89	19 32	15 86	18 52	16 70	17 68	17 68	25
26	20 88	15 49	20 10	16 49	19 26	17 46	18 38	18 38	26
27	21 69	16 08	20 87	17 13	20 00	18 13	19 09	19 09	27
28	22 49	16 68	21 64	17 76	20 75	18 70	19 80	19 80	28
29	23 29	17 27	22 42	18 40	21 49	19 44	20 51	20 51	29
30	24 10	17 87	23 19	19 03	22 23	20 12	21 21	21 21	30
31	24 90	18 47	23 96	19 67	22 97	20 82	21 92	21 92	31
32	25 70	19 06	24 74	20 30	23 71	21 49	22 63	22 63	32
33	26 51	19 66	25 51	20 93	24 45	22 16	23 33	23 33	33
34	27 31	20 25	26 28	21 57	25 19	22 83	24 04	24 04	34
35	28 11	20 85	27 06	22 20	25 93	23 50	24 75	24 75	35
36	28 91	21 46	27 83	22 84	26 67	24 17	25 46	25 46	36
37	29 72	22 04	28 60	23 47	27 41	24 85	26 16	26 16	37
38	30 52	22 64	29 37	24 11	28 16	25 52	26 87	26 87	38
39	31 32	23 23	30 15	24 74	28 90	26 19	27 56	27 56	39
40	32 13	23 83	30 92	25 38	29 64	26 86	28 28	28 28	40
41	32 93	24 42	31 69	26 01	30 38	27 53	28 99	28 99	41
42	33 73	25 02	32 47	26 64	31 12	28 21	29 10	29 10	42
43	34 53	25 61	33 24	27 28	31 86	28 88	30 41	30 41	43
44	35 34	26 21	34 01	27 91	32 60	29 55	31 11	31 11	44
45	36 14	26 81	34 78	28 55	33 34	30 22	31 82	31 82	45
46	36 94	27 40	35 56	29 18	34 08	30 89	32 53	32 53	46
47	37 75	28 00	36 33	29 82	34 82	31 56	33 23	33 23	47
48	38 36	28 59	37 10	30 45	35 57	32 23	33 94	34 94	48
49	39 17	29 19	37 88	31 08	36 31	32 91	34 65	34 65	49
50	40 17	29 78	38 65	31 72	37 05	33 58	35 35	35 35	50
60	48 19	35 74	46 38	38 06	44 45	40 29	42 43	42 43	60
70	56 22	41 69	54 11	44 41	51 85	47 00	49 49	49 49	70
80	64 25	47 65	61 84	50 75	59 26	53 72	56 56	56 56	80
90	72 28	53 61	69 57	57 09	66 67	60 44	63 63	63 63	90
100	80 32	59 56	77 30	63 43	74 08	67 15	70 71	70 71	100
200	160 64	119 12	154 60	126 86	148 16	134 30	141 42	141 42	200
	E. W.	N. S.	E. W.	N. S.	E. W.	N. S.	E. W.	N. S.	
	4 Points 3 Quar.		4 Points 2 Quar.		4 Points 1 Quar.		4 Points.		
	53 Deg. 26 M.		50 Deg. 37 M.		47 Deg. 49 M.		45 Deg. 00 M.		

OTHER

NAUTICAL QUESTIONS,

Performed by *Protraction* and *Calculation*, either by the Tables of *Sines*, *Tangents*, and *Logarithms*, or by the *Proportional Scales*.

QUEST. I. *There are two Ships that set Sail from the Port* A, *the one sails directly North*, 2941 *Leagues, to* C; *and the other directly East*, 33.26 *Leagues, to* B: *I demand how the two Ships bear one from the other, and also how far they are asunder?*

By *Protraction*.

Fig. III. DRaw a Right Line, A B, and upon A erect the Perpendicular A C: Let A represent the Port from whence the Ships set Sail; then (because the First Ship sailed 29.41 Leagues North) take from any Scale of Equal Parts 29.41 Leagues, and set them from A to C; so shall C be the place of the First Ship. Now, (because the other Ship sailed directly East, which is one Quarter of the Compass distant from the North,) therefore the Angle at A must be a Right Angle: And because the second Ship sailed East 33.26 Leagues, take 33.26 Leagues from the same Line of Equal Parts, and set them upon the Line A B, from A unto B; so shall B be the Place of the second Ship.

Now to know how these two Ships bear one from another, draw the Line C B, and measure the Quantity of the Angle at B, which you shall find to be 33 deg. 45 min. which is 3 Points from the West, Northerly, that is, the N. W. by W. Point of the Compass; and so doth the second Ship B, bear from the first Ship C.—— Again, Find the Quantity of the Angle at C, which you shall find to be 56 deg. 15 min. which is 5 Points from the South, Easterly; that is, the S. E. by E. Point of the Compass; and so do the two Ships bear one from the other.— Then from the Distance that the two Ships are from each other, take in your Compasses the Distance between B and C, which measure upon your Scale of Equal Parts, and you will find it to contain 40 Leagues; and so far asunder are the two Ships B and C.

By *Calculation*.

The Bearing of the Ships one from the other is found by the IV. *Case* of *Right-angled Plain Triangles*, by this Analogy.

As the Distance that the first Ship sailed, 29.41 Leagues,
Is to the Distance that the second Ship sailed, 33.26 Leagues;
So is the *Radius*,
To the *Tangent* of the *Angle* that the first Ship bears from the second, 56 deg. 15 min. or S. E. by E. The Complement whereof, 33 deg. 45 min. or N. W. by W. is the Bearing of the second Ship from the first.

The Distance of the Ships from each other, is found by the VI. *Case*, by this Analogy.

As the Sine of the Bearing of the first Ship, 33 deg. 45 min. or N. W. by W.
Is to the Distance that the second Ship sailed;
So is the *Radius*, 90 deg.
To the Distance of the two Ships.

II. *A Ship at* A *discovers an Island at* C, *lying from her directly East; but she sails from* A *towards* B 33.26 *Leagues directly South; but her Compass coming to some Mischance, that use cannot be made of it, she again at* B *discovers the same Island, and sails upon an unknown Point of the Compass directly upon the Island, and touches upon it, having sailed* 40.00 *Leagues.—I demand upon what Point of the Compass the Ship sailed from* B *to* C, *and also how far off the Island was from* A, *where it was first discovered.*

By *Protraction*.

DRaw a Line C A, representing a Line of East and West, and upon A erect a Perpendicular A B, and from A to B set off 40.00 Leagues, the Distance that the

the Ship failed frhm A to B. Then take out of your Scale of Equal Parts 40.00 Leagues, the Distance that the Ship sailed from B to the Island; and setting one Foot of the Compasses in B, with the other describe an obscure Arch of a Circle *m m*, crossing the East and West Line in C; so is C the Place of the Island.

Now first, to find upon what Point of the Compass the Ship sailed from B to the Island, you must find the Quantity of the Angle at B, and you shall find it to contain 33 deg. 45 min. or the N. E. by N. and upon that Point did the Ship sail from B to the Island at C.—— Then, to know how far the Island C was from A, where it was first discovered, take in your Compasses the length of the Line A C, and measure it upon your Scale; so shall you find that to contain 24 *Cent.* or $\frac{4}{5}$ Leagues; and so far distant was the Island from A.

By *Calculation.*

The Point of the Compass that the Ship sailed upon from B to C, may be found by the V. *Case* of *Right-angled Plain Triangles*, by this Analogy.

As the Distance which the Ship sailed from B to C, 40.00 Leagues,
  Is to the *Radius*;
So is the Distance sailed between A and B, 33.26 Leagues,
  To the Co-sine of the Point that the Ship sailed upon from B to C, 56 d. 15 m.

The Distance that the Ship was from the Island, when first discovered, may be found by the VII. *Case* of *Right-angled Plain Triangles*, by the following Analogy.

(1) As the Distance that the Ship sailed from B to C, 40.00 Leagues,
  Is to the *Radius*;
So is the Distance that the Ship sailed from A to B, 33.26 Leagues,
  To the Bearing of the Island from B, 33 d. 45 m.
(2.) As the *Radius*,
  Is to the Distance that the Ship sailed from C to B, 40.00 Leagues;
So is the Sine of the *Rumb* that the Ship sailed upon from B to C, 33 d. 45 m.
  To the Distance of the Island from A, 29.41 Leagues.

III. *There are two Ports at* A *and* B, *which are distant* 33.26 *Leagues, and lie directly North and South of each other; from whence two Ships set sail, both for the Port* C: *The Ship at* B *sails away upon a South-West by South Point, and the Ship at* A *sails directly West.*—— *I demand, how many Leagues either of the Ships had sailed when they met at the Port* C, *and also how the Port* C *did bear from that at* B.

By *Protraction.*

DRaw a Right Line, A B, and upon it set off 33.26 Leagues. Now because the Ship at B steered a South-West by South Course, which is three Points from the South Westerly, therefore upon the Point B protract an Angle of 33 deg. 45 min. and draw the Line B C.—— Then, because the Ship at A steered a Westerly Course, which is a Quarter from the North, upon the Point A protract an Angle of 90 deg. and draw the Line A C, cutting the former Line B C in C.—— Now to know how many Leagues each Ship sailed, take in your Compasses the Length of the Line B C, and measuring it upon your Scale, you shall find it to contain 40.00 Leagues; and so many did the Ship that came from B sail. Also take the Length of the Line A C in your Compasses, and measuring that upon your Scale, it will be found to contain 22.22 Leagues; and so much did the Ship that came from A sail. Now to know how the Port at C did bear from that at B, find the Quantity of the Angle at C, which you shall find to be 56 deg. 15 min. that is, Five Points from the East Northerly, namely, N. E. by N. and so did the Port C bear from B.

By *Calculation.*

The finding of the Distance that each Ship sailed, may be done by the I. and II. *Cases* of *Right-angled Plain Triangles*, by this Analogy:

As the Distance of the two Ports, A and B, 33.26 Leagues,
  Is to the Bearing of the Port C from B, 56 deg. 15 min.
So is the Sine of the *Rumb* that the Ship sailed upon from B to C, 33 deg. 45 min.
  To the Distance that the Ship sailed from A to C, 22.22 Leagues.
And so is the *Radius*,
  To the Number of Leagues that the Ship sailed from B to C, 40.00 Leagues.

IV. *A*

IV. *A Ship at* C *discovers a Point of Land at* A, *bearing from her S. S. E. but she shapes a Course E. by S. and sails away* 40.00 *Leagues to* B, *and at* B *she discovers the same Point of Land bearing from her W. S. W.—— I demand how far the Ship was from Land, being at* C *and* B.

By *Protraction.*

DRaw a Line C B, containing 40 Leagues, and upon C protract an Angle of 56 deg. 15 min. or Five Points, which is the Difference the Point of Land did bear from the Ship being at C, and the Point upon which she sailed from C to B; and draw a Right Line C A.—— Then upon the Point B protract an Angle of 33 deg. 45 min. which is the Difference of the Ship's Bearing from C and A, she being at B, namely, W. S. W. and draw the Line B A, cutting the Line C A, before drawn, in A.

Now to find how far the Ship was from Land being at C, measure the Line C A upon your Scale of Equal Parts, and you shall find it to contain 22.22 Leagues; and so far was the Ship from the Land when she was at C. Also measure the Length of the Line B A, and you shall find that to contain 33.26 Leagues; and so far from Land was the Ship being at B.

By *Calculation.*

To find these Distances, you may do it by the III. *Case* of *Right-angled Triangles*, by this Analogy.

As the *Radius*,
Is to the Distance that the Ship sailed from C to B, 40.00 Leagues;
So is the Bearing of the Ship, being at C, 56 d. 15 m.
To her Distance from Land, being at B, 33.26 Leagues. Or,
The Bearing of the Ship, she being at B, 33 d. 45 m.
To her Distance from Land at C, 22.22 Leagues.

V. *A Ship being at* A, *discovers two other Ships at* C *and* B; *the Ship at* C *bears from her directly East, and the other Ship at* B *bears from her directly South: The Ship at* A *sails directly South,* 22.22 *Leagues to* B, *and being at* B, *steers away upon an unknown Course to* C, 40 *Leagues.—— I demand upon what Point the Ship sailed from* B *to* C, *and also how far* C *is distant from* A.

By *Protraction.*

DRaw a Right Line, A B, for the Bearing of the Ship B from the Ship A, which was direct South: Also from A draw another Line, A C, for the Bearing of the Ship C from the Ship A, which was directly East. Now because between the South and the East is 90 deg. or one Quarter of the Compass, therefore upon the Point A protract an Angle of 90 deg. drawing the Lines A C and A B at Right Angles. This done, take 33.26 Leagues out of your Scale of Equal Parts, which is the Distance that the Ship sailed South from A to B. Then take from the same Scale 40 Leagues, which is the Distance that the Ship sailed from B to C upon an unknown Point; and with this Distance, setting one Foot of the Compasses in B, with the other describe an obscure Arch of a Circle, *m m*, cutting the Line A C in the Point C, and draw the Line C B.—— Now to find upon what Point of the Compass the Ship sailed from B to C, find the Quantity of the Angle at B, which you shall find to contain 33 deg. 45 min. that is three Points from the North Easterly, namely, N. E. by N. and upon that Point did the Ship sail from B to C.—— Then to find how far C is distant from A, take the Line C A in your Compasses, and measuring it upon your Scale, you shall find it to contain 22.22 Leagues; and so far is C distant from A.

By *Calculation.*

The Point upon which the Ship sailed from B to C, may be found by the III. *Case* of *Right-angled Triangles*, by this Analogy.

As the Distance that the Ship sailed from B to C, 40.00 Leagues,
Is to the *Radius*;
So is the Distance that the Ship sailed from A to B, 22.22 Leagues,
To the Co-sine of the *Rumb* from the *Meridian*, 33 deg. 26 min.

Then

Then for the Distance of C *from* A.

As the *Radius*,
Is to the Distance that the Ship sailed from B to C, 40.00 Leagues;
So is the *Rumb* from the *Meridian* that the Ship sailed upon from B to C, 33 d. 45 m.
To the Distance of C A, 22.22 Leagues.

VI. *Two Islands at* A *and* C *are discovered by a Ship at* B; *the Island* A *bears from the Ship at* B, *N. N. W. and the Island at* C *bears N. by E. from* B: *The Ship being at* B *sails away N. N. W. to the Island* A, *and having sailed* 33.26 *Leagues, touches upon the Island, and being there, finds that the Island* C *bears from the Island* A, E. N. E. *I demand how far the Ship at* B *was from the Island* C, *and also how far the two Islands were asunder.*

By *Protraction.*

DRaw a Line A B, and upon it set 33.26 Leagues, which is the Distance that the Ship sailed from B to the Island at A. And because the Island A did bear from B, N, N W, and the Island at C, N by E, which are three Points, or 33 deg. 45 min. asunder, upon the Point B protract an Angle of 33 deg. 45 min. and draw the Line B C. Then because the Island at C bears from the Island at A, E N E, which is eight Points, or 90 deg. from N N W, upon the Point A protract an Angle of 90 deg. and draw the Line A C, cutting the Line B C in C.

Now to find the Distance of the Ship being at B from the Island C, take the Line C B in your Compasses, and applying it to your Scale, you shall find it to contain 40.00 Leagues; and so far was the Ship at B from the Island at C. And to find the Distance of the Islands one from the other, take C A in your Compasses, and measure it upon your Scale, you shall find it to contain 22.22 Leagues; and so far distant were the Islands one from the other.

By *Calculation.*

The Distance from A to C may be found by the I. *Case* of *Right-angled Plain Triangles*, by this Analogy.

As the Co-sine of the *Rumb* that the Ship sailed upon from B to A, 56 d. 15 m.
Is to the Distance that the Ship sailed from B to A, 33.26 Leagues;
So is the *Radius*,
To the Distance of the Ship at B, from the Island at C, 40.00 Leagues.

Then for the Distance of the two Islands, by the IV. *Case*, say,

As the *Radius*,
Is to the Distance C B, 40.00 Leagues;
So is the Sine of the Difference between the Bearing of the two Islands from B, 33 d. 45 m.
To the Distance of the two Islands C and A, 22.22 Leagues.

VII. *Two Ships set out from one and the same Port*, A; *the Ship* C *sails* 33.26 *Leagues directly East, and the Ship* B *sails away* 22.22 *Leagues directly South. When they have thus sailed, I demand how far the two Ships are from each other.*

By *Protraction.*

DRaw a Right Line A B, and set off upon it 33.26 Leagues, the Distance that the Ship sailed from A to B South. Then, because the other Ship sailed directly East, which is 90 deg from the South, upon the Point A erect the Perpendicular A C, and upon it set off 22.22 Leagues, from A to C, which was the Distance the other Ship sailed East. Then draw the Line C B, which being taken in your Compasses, and measured upon your Scale, will be found to contain 40.00 Leagues; and so far are the two Ships from each other.

By *Calculation.*

This Distance may be found by the VI. *Case* of *Right-angled Plain Triangles*, by this Analogy.

(1.) As the Distance that the Ship sailed from A to B, 33.26 Leagues,
Is to the Distance that the Ship sailed from A to C, 22.22 Leagues;

So

So is the *Radius*,
To the *Tangent* of the *Angle* at B, 33 deg. 45 min.
(2.) As the Sine of the *Angle* at B, 33 deg. 45 min.
Is to the Distance C A, 22.22 Leagues,
So is the *Radius*,
To the Distance C B, 40.00 Leagues.

VIII. *Two Ships set sail from the Port at* K; *the one sails* 3.77 *Leagues upon the* S. W. *Point towards* M, *the other sails* 8.00 *Leagues upon the* West *Point towards* L.— *I demand how many Leagues the Ships at* M *and* L *are asunder: and also how the Ship at* M *bears from the Port* K, *and the other Ship at* L.

By *Protraction.*

Fig. IV. DRaw a Right-Line K L, and by help of your *Scale* set off upon it 8 Leagues, the Distance that the Ship sailed from K to L upon the *West*-Point: Then because the other Ship sailed 3.77 Leagues from K towards M, upon the *S.W.* Point, which is 45 deg. or 4 Points from the *West*: therefore upon the Point K, Protract an *Angle* of 45 deg. and draw the Line K M, setting off upon it from K to M 3.77 Leagues, the Distance that the Ship sailed from K to M, and draw the Line M L.

Now to know, first, how far distant the Ships at M and L are from each other, take in your *Compasses* the length of the Line M L; which apply to your *Scale*, and you shall find it to contain 5.96 Leagues.— And, Secondly, to find how the Ship at M bears from the Port K, and the other Ship at L, you must find the quantity of the *Angle* at M, which you will find to be 108 deg. 28 min. that is Nine Points and a half and 1 deg. 35 min. Now, because the Course from K to M was *S. W.* therefore the Ship at M bears from the Port K North-east. And seeing that the *Angle* at M, is 108 deg. 28 min. or 9 Points and a half, and 1 deg. 35 min. therefore so many Points counted from the N E Point, is the Bearing of the Ship at M, from that at L; which will be W N W, half a Point and 1 deg. 35 min. *Westerly.*

By *Calculation.*

As the Summ of Leagues that both Ships have sailed, 11.77
Is to the Difference of their Leagues sailed, 4.23
So is the *Tangent* of half the Summ of the *Angles* at M and L, 67 deg. 30 min.
To the *Tangent* of 40 deg. 30 min.

Which added to 67 deg. 30 min. gives 108 deg. 28 min. for the *Angle* at M; and subtracted from 67 deg. 30 min. leaves 26 deg. 32 min. for the *Angle* at L.

And to find how far the two Ships are Distant.

As the Sine of the *Angle* at L, 26 deg. 32 min.
Is to the Leagues the first Ship sailed K M, 3.77
So is the Sine of the Course she steered 45 deg.
To 5.96 Leagues.

Which is the Distance of the Ship M from the Ship L.

IX. *There are three Ships,* K, L, *and* M: *the Ship* K *is distant from the Ship* L 8.00 *Leagues; the Ship at* L *is distant from that at* M 5.96 *Leagues; and the Ship at* M *is distant from that at* K 3.77 *Leagues; and they lie directly* North *and* South.— *I demand how the Ship at* M *bears to that at* L, *and how that at* L *bears to that at* K.

By *Protraction.*

DRaw a Right Line, and out of your Scale take 8.00 Leagues, and set them thereon from K to L, for the distance of the Ships at K and L. Then take 3.77 Leagues, the distance of the Ship's K and M, out of your Scale; and setting one Foot of the *Compasses* in K, with the other describe the obscure Arch of a Circle *o o*. Again, take 5.96 Leagues from your Scale, which is the distance that the Ship L was from the Ship M; and setting one Foot of the *Compasses* in L, with the other describe the obscure Arch of a Circle *n n*, crossing the former Arch in the Point M: Then draw the Lines M K and M L; so have you their true Positions.

Now

Now to find their Bearing one from another; forasmuch as the Ships M and K did lie *North* and *South* of each other, find the quantity of the Angle at M, which is 108 deg. 28 min. that is nine Points and a half, and 1 deg. 35 min. from the *South Eastward*, which will be the *N. W.* Point: and so doth the Ship M bear from that at K. And for the Bearing of that at K from that at L, find the quantity of the Angle at L, it will be found as before W N W, half a Point, and 1 deg. 35 min. *Westerly*.

The Bearings of the Ships from each other may be found by the Fifth Case of Oblique-angled plain Triangles, by the Analogie in that Case set down.

Problems of Sailing by the Plain Sea-Chart, *both by* Trigonometrical Calculation, *and wrought upon the* Chart *it self*.

A*Mong* Sea-men *there are* Three *principal ways of* Sailing *most in* Use and Practice: *Two whereof are* Rectilineal, *performed by* Right-Lines; *the Third is* Spherical *or* Circular, *performed by* Arches *of* great Circles *of the* Sphere.

Of the Two first, the one is called Plain Sailing, *or* Sailing *by the* Plain Sea-Chart.

The other is called Mercator's Sailing; *or* Sailing *by* Mercator's Chart.

These two Charts *are both of them composed of* Right-Lines, *yet differ both in their* Construction *and* Use, *though not so much in their* Use, *as in their* Making *or* Construction.

The Plain Sea-Chart *consisteth of* Meridians *and* Parellels, *which are drawn in all parts equal from the* Æquinoctial *towards either of the* Poles; *which is erroneous, as hereafter shall be discovered.*

Mercator*'s* Chart, (*or rather Mr.* Wright*'s* Chart) *hath the Degrees of* Longitude *in every* Parallel of Latitude *equal to those in the* Æquinoctial, *as the* Plain-Chart *hath: But the Degrees of* Latitude *do increase more and more (as they grow nearer the* Poles) *in such a Proportion as every* Parallel of Longitude *doth decrease.*

The way of Sailing by the Plain Sea-Chart *is much in use, nay too much, considering the* Errors *that it leads* Sea-men *into; though they are not so easily discovered in* short *as* long Voyages, *nor in* Places near *the* Æquinoctial *as those* nearer *the* Poles. *But, I suppose, it is more used for the ease there is in* Projecting *of this* Chart, *than in that of* Mercator*'s: otherwise I know not why that should be so as it is embraced, and the other (I mean that of* Mercator's) *so much neglected; which comes so near to the* Spherical *way of* Sailing, *that there is an insensible difference between them. But I shall compare them together, so that the* ingenious Sea-man *may see their Difference, and thereby abandon* Error, *and embrace the* Truth. *For in the following* Problems *I shall perform the* same *thing by* both Charts, *by which the* Errors *may more palpably be discovered. And I shall shew how the Doctrine of* Plain Triangles *may be made applicable to the Solution of the following* Nautical Problems.

The Making of the Plain Sea-Chart.

A *Sea-Chart* may be made either *general*, or *particular*. A *general Sea-Chart* is that whose Degrees of *Latitude* proceed from the *Æquinoctial* to either *Pole*, which in the *common Sea-Chart* may be done; but it will be egregiously false, as the Degrees of *Latitude* grow nearer the *Pole*, as I have already declared.— A *Particular Sea-Chart* is such a one as is made properly for one *particular Navigation*: as if your whole *Navigation* were not to exceed the *Latitudes* of 48 and 60 deg. of *Latitude*, and not to differ in *Longitude* above 8 degrees. *Fig.* V.

Now to *project* or *make* such a *Chart*; First, Draw a Right-Line A B, representing the *Meridian*, and cross it at right-Angles in the Point A with another Right-line A D, representing the Parallel of your least *Latitude*, namely, of 48 deg.— Secondly, Consider what distance you will have your Parallels of *Longitude* and *Latitude* to be, (for in this *Chart* they are both equal,) whether 1, 2, 3, or 4 Inches, (for the larger the better.)

better.) But in this *Example* I have made them onely half an Inch. I take therefore half an Inch out of an exact *Scale*, and run it upon the *Meridian-Line* A B, from A to 49, from 49 to 50, from 50 to 51, *&c.* till I come to my greatest *Latitude*, which is here supposed to be 60 deg. — Thirdly, Run the same Distance of half an Inch from A towards D, upon the Line A D, eight times, because the Difference of *Longitude* in your whole *Navigation* will not exceed 8 deg. — Fourthly, Draw the Line C D, parallel to A B, and B C, parallel to A D, and run the same Distances upon the Line B C as are upon the Line A D, and the same upon C D as are upon the Line A B.— Fifthly, From each Degree of *Latitude* in the Line A B, draw to the like Degree of *Latitude* in the Line C D a Right Line, as 49, 49; 50, 50; 51, 51; 52, 52; *&c.* till you have drawn all your *Parallels* of *Latitude.*— Sixthly, For your *Meridians*, they are to be drawn in like manner as were the *Parallels* of *Latitude*, all of them equidistant, and parallel to your first *Meridian* A B, as the Lines 1, 1; 2, 2; 3, 3; *&c.* And by this means have you the *Meridians* and *Parallels* drawn.

The *grand Divisions*, or *whole Degrees*, being thus set upon your *Chart*, we now come to sub-divide them. And for the dividing of the Degrees of the *Æquinoctial* at the top and bottom of your *Chart*, let each of them be divided into 5 or 10 parts, and each of those parts sub-divided into 5 or 10 more less parts, according as quantity will permit; for every one of them is supposed to be divided into 100 or 1000 parts.

For the dividing of the Degrees of *Latitude*; they may be divided as those of *Longitude* were, into 100 parts. But sometimes each Degree is subdivided into 60 Minutes, or *English* Miles, or into 20 Leagues. — Now I have divided the Degrees of *Latitude* in this *Chart* each of them into 5 parts, by which means it is capable of the *Numeration*, either by Miles, Leagues, Centesms, or 100 parts. —— For if you count by 60 Minutes, or Miles, then every of those Divisions will be 12 Minutes, or Miles; if by 20 Leagues, then every Division will contain 4 Leagues; and if by Centesms or 100 parts, then every of them is 20 Centesms. And thus much concerning the Making or Projecting of this *Chart*. I now come to shew

Some Uses of the Plain Sea-Chart.

PROB. I. *How to set any Place upon your* Chart *according to its* Longitude *and* Latitude.

IF the two Places lie under one and the same Parallel, differing not at all in *Latitude*, but onely in *Longitude*, then the Course leading from the one to the other is directly *East* or *West*. As E and F are two Places lying under the Parallel of 50 deg. of *Latitude*, and differ in *Longitude* 5.5 deg. lay a Ruler to 5.5 deg. both at the top and bottom of the Chord, and where the Ruler crosseth the Parallel of 50 deg. as at F, there is your other Place upon the *Chart*. So E and F lie in 50 deg. of *Latitude*, and differ in *Longitude* 5.5 deg.

But if the two Places to be set upon the *Chart* differ onely in *Latitude*, and lie under the same *Meridian* as G F, then the Course leading from the one to the other is directly *North* or *South*, and the difference of *Latitude* of F and G is 2 deg. G lying in the *Latitude* of 48 deg. and F in the *Latitude* of 50 deg.

But if the Places to be set upon the *Chart* differ both in *Longitude* and *Latitude*, as A and F, then the Course leading from the one to the other is upon some other Point of the *Compass*, so far distant from the *Meridian* as is the quantity of the Angle E A F; which here is 70 deg. 1 min. that is, upon the E N E Point 2 deg. 31 min. *Easterly*.

Fig. VI. This Angle may be found either by Protraction by your Line of Chords, or it may be protracted by a *Protracting Quadrant*, such as is in *Fig.* VI. which in all these Operations upon the *Chart* is best, for that it avoids the drawing of Arches of Circles upon your *Chart* or *Blank*. So then if you were to Protract the Angle E A F by your *Protracting Quadrant*, lay the Centre A of your *Quadrant* upon the Point A in your *Chart*, and the *Meridian-Line* of the *Quadrant* A B upon the *Meridian-Line* of your *Chart*; then will the Line A C of the *Quadrant* lie upon the Parallel A D of your *Chart*: and the Angle that you are to Protract being 70 deg. 1 min. by the edge

edge of your *Quadrant* make a small Mark or Prick with your Needle, and from A through that Point draw a Right-Line, which will be the Line A F.

And in the same manner as you set any Place upon your *Chart*, you may find in what *Latitudes* and Difference of *Longitude* any Places already set upon your *Chart* are in.

II. *Any Places being set upon the* Chart, *to find in what* Latitudes *they are, and also how they differ in* Longitude.

LET the Points Q and R upon the *Chart* be two Places, and I would know in what *Latitudes* they lie. First, Through the Point Q draw a Line parallel to the Line B C of your *Chart*; and also through the Point R draw another Line parallel to A C. The Line that is drawn through Q shoots upon the *Latitude* of 58 deg. 36 min. and the Line passing through R cuts the *Meridian* of the *Chart* on either side at the *Latitude* of 57 deg. 16 min. And under those two *Latitudes* are the two Places Q and R.

Then to find their Difference of *Longitude*, take in your *Compasses* the Distance between R and S, and measuring it upon the bottom of the *Chart*, it will reach from A to 4 deg. 24 min. and such is the Difference of *Longitude* of the two Places Q and R.

III. *Having the Rumb, and the Distance that the Ship hath run upon that Rumb, to find the Difference of* Longitude *and* Latitude.

The Analogie or Proportion.

As the *Radius*,
  Is to the Distance run,
So is the Sine of the *Rumb*,
  To the Difference of *Longitude*:
    And
So is the Co Sine of the *Rumb*,
  To the Difference of *Latitude*.

So the *Rumb* being 70 deg. 1 min. that is E N E, 2 deg. 31 min. *Easterly*, and the Distance run 117 Leagues, the Difference of *Longitude* will be found to be 5.5 deg. and the Difference of *Latitude* 2 deg.

Upon the Chart.

UPon the Point A Protract an *Angle* of 70 deg. 1 min. as the *Angle* E A F, and and draw the Line A F, which is the *Rumb* upon which the Ship sailed. Upon this Line set 117, the Number of Leagues that the Ship sailed from A to F. Then through the Point F draw the Line F E parallel to A D. So shall E F be the Difference of *Longitude*, 5 deg. and an half, and A E, the Difference of *Latitude*, 2 deg.

IV. *The Difference of* Latitude, *and the* Rumb *being given, to find the Distance run and the Difference of* Longitude.

The Analogie or Proportion.

As the Co-Sine of the *Rumb*,
  Is to the Difference of *Latitude*,
So is the *Radius*,
  To the Distance run:
    And
So is the Sine of the *Rumb*,
  To the Difference of *Longitude*.

So the one *Latitude* being 48 deg. and the other 50 deg. the Difference is 2 deg. and the *Rumb* being E N E 2 deg. 31 min. *Easterly*, the Distance run will be found to be 117 Leagues, and the Difference of *Longitude* 5.5 deg.

Upon the Chart.

SET the difference of *Latitude* 2 deg. from A to E, and draw the Line E F parallel to A D. Then upon the Point A protract the *Angle* of the *Rumb* 70 deg. 1 min. E N E 2 deg. 31 min. *Easterly*, and draw the Line A F, cutting the other Line E F in F. Then taking in your *Compasses* the length of the Line A F, and measuring it upon the side of the *Chart*, you shall find it to contain 117; which is the number of Leagues the Ship sailed: and the Line E F, being so measured, will contain 5.5 deg. the Difference of *Longitude*.

V. *Having the Difference of* Longitude, *and the* Rumb *given, to find the Distance run, and Difference of* Latitude.

The Analogy or Proportion.

As the Sine of the *Rumb*,
Is to the Difference of *Longitude*,
So is the *Radius*,
To the Distance run:
And
So is the Co-Sine of the *Rumb*,
To the Difference of *Latitude*.

So the *Rumb* being E N E 2 deg. 31 min. *Easterly*, and the Difference of *Longitude* 5.5 deg. the Distance run will be found to be 117 Leagues, and the Difference of *Latitude* 2 deg.

Upon the Chart.

UPon the Point Point A Protract an *Angle* of the *Rumb* 70 deg. 1 min. and draw the Line A F. Then the Difference of *Longitude* being 5.5 deg. count 5.5 deg. upon the bottom of your *Chart* from A to G, and upon the Point G raise a Perpendicular G F, cutting the Line A F before drawn in F. Then the Line A F, being measured upon the side of your *Chart*, will be found to contain 117 Leagues, the Distance run: And F G, there also measured, will be found to be 2 deg. the difference of *Latitude*.

VI. *The Distance that the Ship hath run, and the Difference of* Latitude *given, to find the* Rumb, *and Difference of* Longitude.

The Analogy or Proportion.

As the Distance run,
Is to the *Radius*,
So is the Difference of *Latitude*,
To the Co-Sine of the *Rumb*:
And
So is the Sine of the *Rumb*,
To the Difference of *Longitude*.

So the Distance run being 117 Leagues, and the Difference of *Latitude* being 2 deg. the *Rumb* will be found to be E N E 2 deg. 31 min. *Easterly*, and the Difference of *Longitude* 5.5 degrees.

Upon the Chart.

SET the difference of *Latitude* 2 deg. upon your *Chart* from A to E, and draw the Line E F parallel to A B. Then out of the side of your *Chart* take the distance run 117 Leagues; and setting one Foot of the *Compasses* in A, turn the other about till it cross the Line E F, which it will do in F. Then F E, being measured upon the bottom of your *Chart*, will contain 5.5 deg. the difference of *Longitude*. And by your Line of *Chords*, or *Protracting Quadrant*, find the quantity of the *Angle* E A F, which will be 70 deg. 1 min. the E N E Point 2 deg. 31 min. *Easterly*.

VII. *The*

VII. *The Distance that the Ship hath run, and the Difference of* Longitude *being given, to find the* Rumb, *and Difference of* Latitude.

The Analogy or Proportion.

As the Distance run
Is to the *Radius*,
So is the Difference of *Longitude*
To the *Rumb*:
And
So is the Co-Sine of the *Rumb*
To the Difference of *Latitude*.

So the Difference of *Longitude* being 5.5 deg. and the Distance that the Ship hath run 117 Leagues; the *Rumb* will be found to be E N E 2 deg. 31 min. *Easterly*, and the Difference of *Latitude* 2 deg.

Upon the Chart.

COunt the Difference of *Longitude* upon the bottom of the *Chart* from A to G, and upon the Point G raise the Perpendicular G F: Then take out of the side of your *Chart* the Distance run, 117 Leagues, and setting one foot of the *Compasses* in A, with the other cross the Perpendicular F G in the Point F. Now if you take F G in your *Compasses*, and measure it on the side of your *Chart*, you shall find it to contain 2 deg. for the Difference of *Latitude*; and the *Angle* E A F, being measured by your *Chord* or *Quadrant*, will be 70 deg. 1 min. that is the E N E Point 2 deg. 31 min. *Easterly* for the *Rumb*.

VIII. *The Difference of* Longitude, *and Difference of* Latitude *being given, to find the* Rumb, *and the Distance run.*

The Analogy or Proportion.

As the Difference of *Latitude*
Is to the *Radius*,
So is the Difference of *Longitude*
To the *Tangent* of the *Rumb*:
And
As the Sine of the *Rumb*
Is to the Difference of *Longitude*,
So is the *Radius*
To the Distance run.

So the Difference of *Longitude* being 5.5. deg. and the Difference of *Latitude* 2 deg. the *Rumb* will be found to be E N E 2 deg. 31 min. *Easterly*, and the Distance upon the *Rumb* 117 Leagues.

Upon the Chart.

COunt the Difference of *Latitude* from A to E, and draw the Line E F parallel to A D: also count the Difference of *Longitude* from A to G, and upon the Point G raise the Perpendicular G F, cutting the Line E F in the Point F: Then take in your *Compasses* the length of the Line A F, and measuring it upon the side of the *Chart*, you shall find it to contaiu 117 Leagues, the Distance that the Ship hath run. And if by your Line of *Chords*, or *Quadrant*, you find the quantity of the *Angle* E A F, it will be the *Rumb*; which you may find to be E N E 2 deg. 31 min. *Easterly*, or 70 deg. 1 min.

IX. *The* Rumb *that a Ship hath sailed upon, and the number of Leagues she hath sailed upon that* Rumb, *being given, to know how much she hath raised or depressed the Pole.*

The Analogy or Proportion.

As the *Radius*
Is to the Distance run,
So is the Co-Sine of the *Rumb* from the *Meridian*
To the Difference of both *Latitudes*.

So the *Rumb* being E N E 2 deg. 31 min. Easterly, that is, 70 deg. 1 min. and the Distance that the Ship hath sailed upon that *Rumb* 117 Leagues, the Pole will be found to be raised 2 deg.

Upon the Chart.

UPon the Point A, the lesser Latitude, protract an *Angle* of 70 deg. 1 min. and draw the Line of the *Rumb* A F, and out of the Side of your *Chart* take 117 Leagues, (the Distance the Ship sailed,) and set them upon the *Rumb* from A to F. Then through the Point F, draw the Line E F, parallel to A D, cutting the *Meridian* of your *Chart* in E, which is 2 deg. from A; so that the Ship hath raised the *Pole* 2 degrees.

X. *The* Longitude *and* Latitude *of the* Place *from whence you came*, *with the* Rumb *and* Distance *sailed, being given, to find the* Longitude *and* Latitude *of the* Place *to which you are come.*

The Analogy or Proportion.

As the *Radius*,
Is to the Distance run;
So is the *Sine* of the *Rumb* from the *Meridian*,
To the Difference of *Longitude*: And,
So is the *Co sine* of the *Rumb*,
To the Difference of *Latitude*.

So the *Latitude* of the Place from whence you came being 52 deg. and the *Longitude* 35 deg. the *Rumb* upon which you have sailed N E by N, 33 deg. 45 min. and the Distance which you have sailed upon that *Rumb* 96.2 Leagues; you shall find the Difference of *Longitude* to be 2 deg. 40 min. and the Difference of *Latitude* 4 deg. So that the Place to which you are come is in the *Latitude* of 56 deg. and in the *Longitude* of 37 deg. 40 min.

Upon the Chart.

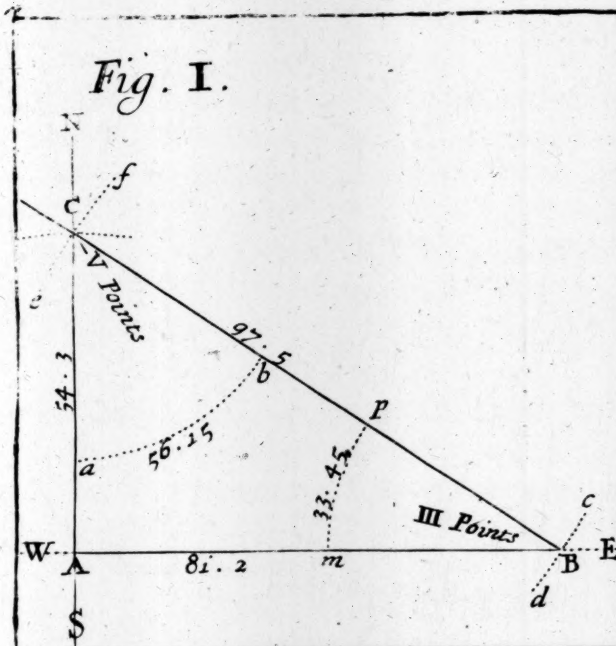
THe Place from whence you came being in the *Latitude* of 52 deg. and in the *Longitude* of 35 deg. is represented by H. The *Rumb* you have sailed upon being N E by N, 33 deg. 45 min. upon the Point H protract an *Angle* of 33 deg. 45 min. and draw the Line H K for the *Rumb*. Then out of the Side of your *Chart* take 96.2 Leagues, which is so much as the Ship sailed, and set that upon the *Rumb-line* from H to K, and through the Point K draw the Line K L, parallel to B C, (or perpendicular to A B,) and it will cut the Line A B in L: So K L being measured on the bottom of your *Chart*, will be found to contain 2 deg. 40 min. the Difference of *Longitude*, which added to 35 deg. the *Longitude* you came from, gives 37 deg. 40 min. for the *Latitude* you are in. Also the Line H L being measured on the Side of your *Chart*, will be found to contain 4 deg. and such is the Difference of *Latitude*; which added to 52 deg. the *Latitude* from whence you came, gives 56 d. the Latitude in which you are.

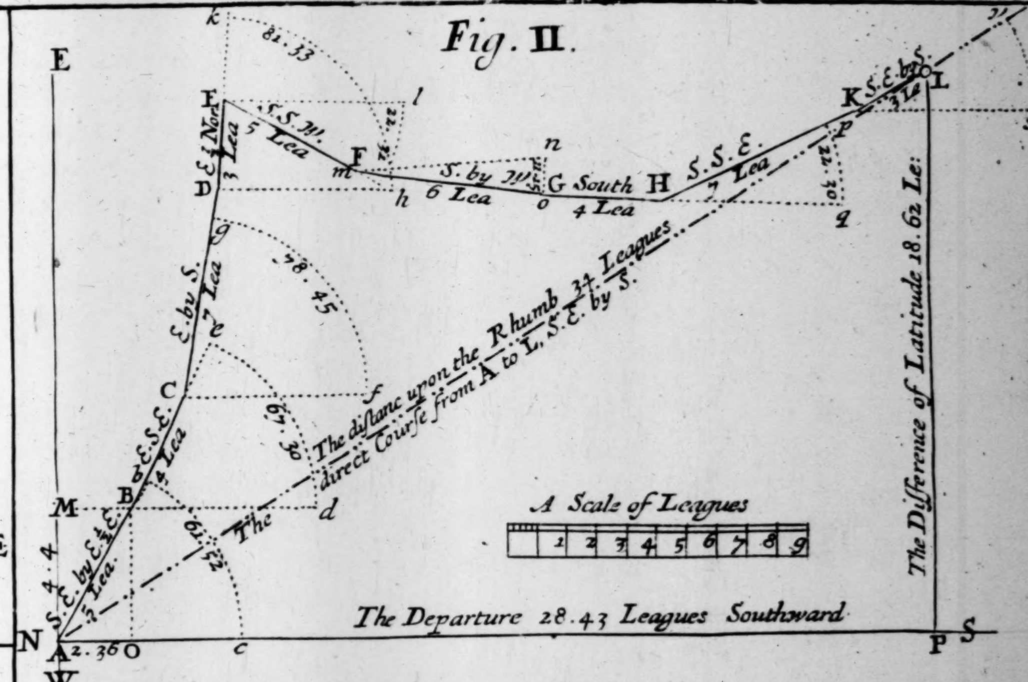
XI. *The* Longitude *and* Latitude *of the Place from whence you came*, *the* Rumb *upon which you sailed, and the* Latitude *of the Place to which you are come, being given, to find the Distance and Difference of* Longitude.

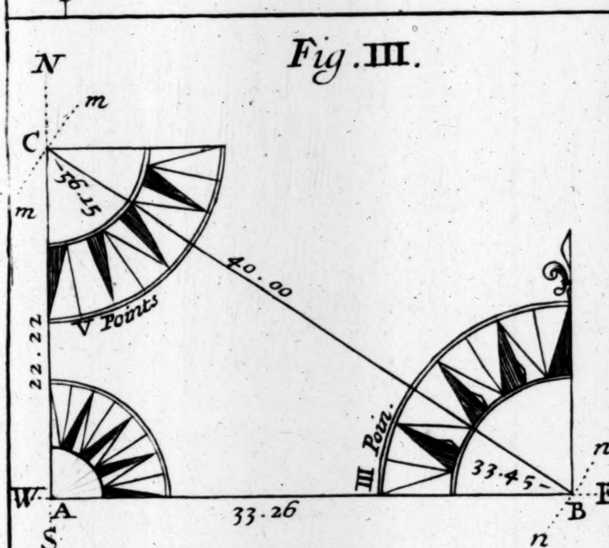
The Analogy or Proportion.

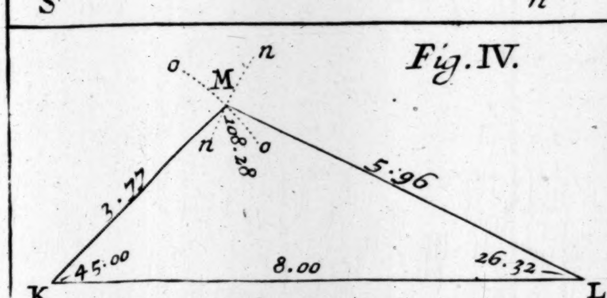
As the Difference of *Latitude*,
Is to the *Radius*;
So is the *Tangent* of the *Rumb* from the *Meridian*,
To the Difference of *Longitude*:
And,
As the *Sine* of the *Rumb*,
Is to the Difference of *Longitude*;
So is the *Radius*,
To the Distance run.

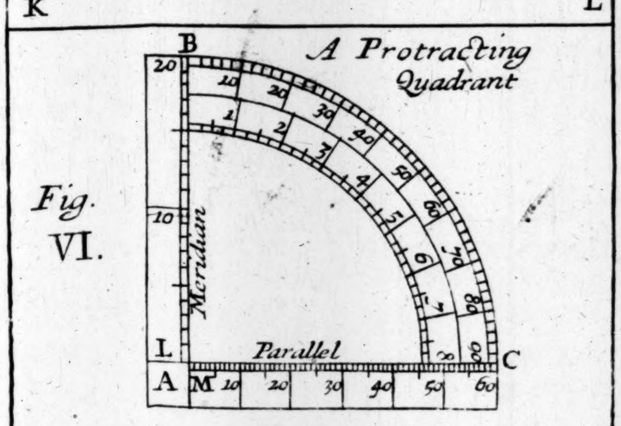
So the *Latitude* of the Place from whence you came being 52 deg. and the *Longitude* 35 deg. and the *Rumb* upon which you sailed the third from the *Meridian*, N E by N,

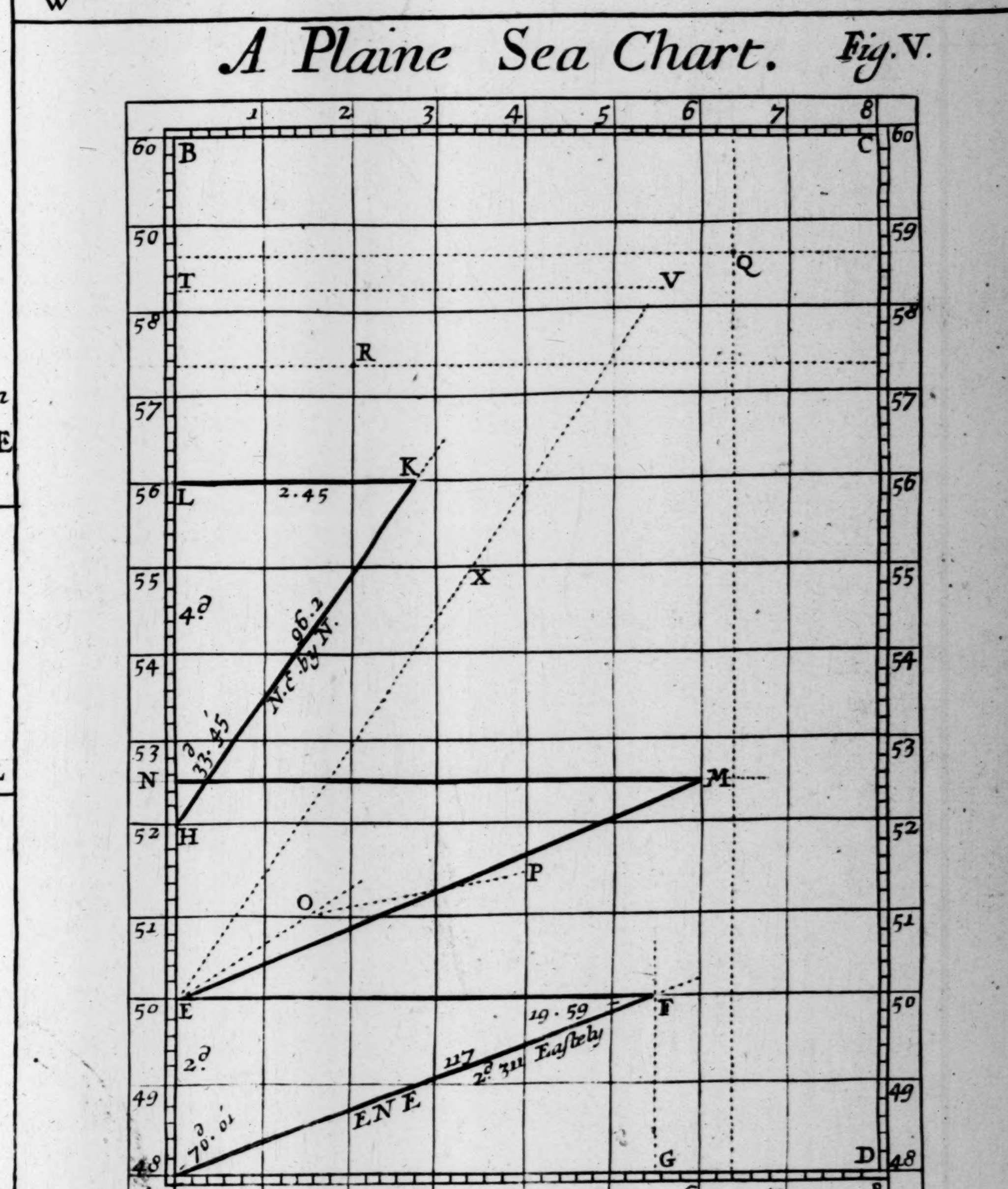












Place this after Page 655, to fold out.

N E by N, 33 deg. 45 m. you shall find the Distance run to be 96.2 Leagues, and the Difference of *Longitude* 2 deg. 40 min.

Upon the Chart.

UPon your Chart assign H for your Place from whence you came, in the *Latitude* of 52 deg. and *Longitude* 35 deg. Upon this Point H protract the *Angle* of the *Rumb*, 33 deg. 45 min. N E by N, and draw the *Rumb-line* H K. Then the *Latitude* of the Place where you are being found, by Observation, (or being otherwise given,) to be 56 deg. draw a Line quite cross your *Chart* at the 56th Degree of *Latitude*, as the Line 56 56, in the *Chart* crossing the *Rumb-line* in the Point K: So K L being measured at the bottom of your *Chart*, will be found to contain 2 deg. 45 min. which added to 35 deg. the *Longitude* you came from, makes 37 deg. 40 min. and that is the *Longitude* in which you are. In like manner, measure H K upon the Side of your *Chart*, and you shall find it to contain 96.2 Leagues; and so much hath the Ship run upon that Point N E by N.

XII. *The* Latitude *of two Places, and the Difference of* Longitude *between them, being known, to find what* Rumb *leadeth from one to the other, And how many Leagues distant they are asunder.*

The Analogy or Proportion.

As the Difference of *Latitude*,
Is to the *Radius*;
So is the Difference of *Longitude*,
To the *Tangent* of the *Rumb*.
And,
As the *Sine* of the *Rumb*,
Is to the Difference of *Longitude*;
So is the *Radius*,
To the Distance of two Places.

So the *Latitude* of one of the Places being 50 deg. and the other 52 deg. 30 min. and the Difference of *Longitude* 6.5 deg. the *Rumb* will be found to be be 67 deg. 23 min. and the Distance upon the *Rumb* 6.5 deg. or 120 Leagues.

Upon the Chart.

UPon the Point of the greater *Latitude* at N, 52 deg. 30 min. draw a Line N M, parallel to A D, upon which Line set 6 deg. the Difference of *Longitude* of the two Places (being taken from the bottom of the *Chart*) from N to M. Then from the Point M draw the Line to E, the lesser *Latitude*, 52 deg. which Line taken in the Compasses, and measured upon the Side of the *Chart*, will be found to contain 6 5 deg. or 130 League. Also the Angle N E M being measured by your *Chord*, or *Protracting Quadrant*, will be found to contain 67 deg. 23 min. which is the *Rumb* leading from one to the other, namely, short of the E N E Point 7 deg. or N E by E 11 deg. 8 min. Easterly.

The End of the Second Part.

OF

NAVIGATION.

PART III.

OF

Mercator's-Sailing.

WHEREIN

The DOCTRINE of RIGHT-LINED TRIANGLES (with the supply of *Meridional Parts*) is applied to PRACTICE, in the Solution of sundry *Nautical Problems* in *Sailing* by the true *Sea-Chart*: All performed, (1.) By *Protraction.* (2.) By *Calculation.* And (3.) Upon the *Chart* it self.

Of the Table *of* Meridional Parts.

THE following *Table* of *Meridional Parts* is onely an Abridgment of Mr. *Edward Wright's* large *Table* of *Latitudes*, which he long since published in his *Book* of the *Correction of Errors in Navigation*, it being to every Six Minutes of a Degree of *Latitude*: So that this *Table* sheweth how many *Meridional Parts* every Degree, and Tenth part of a Degree of *Latitude* is from the *Equinoctial*: And the *Table* begins at 00. deg. 00 min. but proceedeth by every Sixth Minute to 90 deg. or a quarter of the *Compass*: And because in this kind of Projection of the *Sea-Chart*, (as you may perceive by the working upon *Mercator's Chart* as hereafter,) the Degrees of *Longitude* and *Latitude* are not equal; for the Degrees of *Latitude* at every Parallel exceed those of *Longitude* in such proportion, as the Diametre of the *Equinoctial* exceeds the Diametre of the *Parallel*: And therefore these differences of *Longitude* and *Latitude* must first be expressed by some common Measure; for which purpose this *Table* serveth: For that it sheweth how many equal Parts are contained between the *Equinoctial*, and every Degree of *Latitude*: namely, of such equal Parts, as one Degree of *Longitude* contains 60. The Use of this *Table* will appear farther, by resolving the *Problems* following.

A TABLE of Meridional Parts.

Latitude. D.	M.	Meridional Parts.	Latitude. D.	M.	Meridional Parts.	Latitude. D.	M.	Meridional Parts.	Latitude. D.	M.	Meridional Parts.	Latitude. D.	M.	Meridional Parts.	Latitude. D.	M.	Meridional Parts.
0	0	0	5	0	300	10	0	603	15	0	910	20	0	1225	25	0	1550
	6	6		6	306		6	609		6	917		6	1232		6	1557
	12	12		12	312		12	615		12	923		12	1238		12	1563
	18	18		18	318		18	621		18	929		18	1244		18	1570
	24	24		24	324		24	627		24	935		24	1251		24	1577
	30	30		30	330		30	634		30	942		30	1257		30	1583
	36	36		36	337		36	640		36	948		36	1264		36	1590
	42	42		42	343		42	646		42	954		42	1270		42	1596
	48	48		48	349		48	652		48	960		48	1276		48	1603
	54	54		54	355		54	658		54	966		54	1283		54	1610
1	0	60	6	0	361	11	0	664	16	0	973	21	0	1289	26	0	1616
	6	66		6	367		6	670		6	979		6	1296		6	1623
	12	72		12	373		12	676		12	985		12	1302		12	1630
	18	78		18	379		18	682		18	991		18	1308		18	1637
	24	84		24	385		24	689		24	998		24	1315		24	1643
	30	90		30	391		30	695		30	1004		30	1321		30	1650
	36	96		36	397		36	701		36	1010		36	1328		36	1657
	42	102		42	407		42	707		42	1016		42	1334		42	1663
	48	108		48	409		48	713		48	1023		48	1341		48	1670
	54	114		54	410		54	719		54	1029		54	1347		54	1677
2	0	120	7	0	421	12	0	725	17	0	1035	22	0	1360	27	0	1684
	6	126		6	427		6	731		6	1042		6	1367		6	1690
	12	132		12	433		12	738		12	1048		12	1373		12	1697
	18	138		18	439		18	744		18	1054		18	1380		18	1704
	24	143		24	445		24	750		24	1060		24	1386		24	1710
	30	150		30	451		30	756		30	1066		40	1393		30	1717
	36	156		36	457		36	752		36	1072		36	1399		36	1724
	42	162		42	463		42	768		42	1079		42	1406		42	1731
	48	168		48	469		48	774		48	1086		48	1412		48	1738
	54	174		54	475		54	781		54	1092		54			54	1744
3	0	180	8	0	482	13	0	787	18	0	1098	23	0	1419	28	0	1751
	6	186		6	488		6	793		6	1104		6	1425		6	1758
	12	192		12	494		12	799		12	1111		12	1432		12	1765
	18	198		18	500		18	805		18	1117		18	1438		18	1772
	24	204		24	506		24	811		24	1123		24	1445		24	1778
	30	210		30	512		30	818		30	1130		30	1451		30	1785
	36	216		36	518		36	824		36	1136		36	1458		36	1792
	42	222		42	524		42	830		42	1142		42	1464		42	1799
	48	228		48	530		48	836		48	1149		48	1471		48	1806
	54	234		54	536		54	842		54	1155		54	1477		54	1813
4	0	240	9	0	542	14	0	848	19	0	1161	24	0	1484	29	0	1820
	6	246		6	548		6	855		6	1168		6	1491		6	1826
	12	252		12	554		12	861		12	1174		12	1497		12	1833
	18	258		18	560		18	867		18	1181		18	1504		18	1840
	24	264		24	567		24	873		24	1187		24	1510		24	1847
	30	270		30	573		30	879		30	1193		30	1517		30	1854
	36	276		36	579		36	886		36	1200		36	1524		36	1861
	42	282		42	585		42	892		42	1206		42	1530		42	1868
	48	288		48	591		48	898		48	1212		48	1537		48	1875
	54	294		54	597		54	904		54	1219		54	1543		54	1881

A TABLE of Meridional Parts.

Latitude. D.	M.	Meridional Parts.	Latitude. D.	M.	Meridional Parts.	Latitude. D.	M.	Meridional Parts.	Latitude. D.	M.	Meridional Parts.	Latitude. D.	M.	Meridional Parts.	Latitude. D.	M.	Meridional Parts.
30	0	1888	35	0	2244	40	0	2623	45	0	3030	50	0	3475	55	0	3968
	6	1895		6	2252		6	2631		6	3039		6	3484		6	3979
	12	1902		12	2259		12	2638		12	3047		12	3493		12	3989
	18	1909		18	2266		18	2646		18	3056		18	3503		18	4000
	24	1916		24	2274		24	2654		24	3064		24	3512		24	4010
	30	1923		30	2281		30	2662		30	3073		30	3522		30	4021
	36	1930		36	2288		36	2670		36	3081		36	3531		36	4031
	42	1937		42	2296		42	2678		42	3090		42	3540		42	4042
	48	1944		48	2303		48	2686		48	3098		48	3550		48	4053
	54	1951		54	2311		54	2694		54	3107		54	3559		54	4063
31	0	1958	36	0	2318	41	0	2702	46	0	3116	51	0	3569	56	0	4074
	6	1962		6	2325		6	2710		6	3124		6	3578		6	4085
	12	1972		12	2333		12	2718		12	3132		12	3588		12	4096
	18	1979		18	2340		18	2726		18	3143		18	3598		18	4106
	24	1986		24	2348		24	2734		24	3150		24	3607		24	4116
	30	1993		30	2355		30	2742		30	3159		30	3617		30	4128
	36	2000		36	2363		36	2750		36	3168		36	3627		36	4139
	42	2007		42	2370		42	2758		42	3176		42	3636		42	4150
	48	2014		48	2378		48	2766		48	3185		48	3646		48	4161
	54	2021		54	2385		54	2774		54	3194		54	3656		54	4172
32	0	2028	37	0	2393	42	0	2782	47	0	3203	52	0	3665	57	0	4183
	6	2035		6	2400		6	2790		6	3212		6	3675		6	4194
	12	2043		12	2408		12	2798		12	3219		12	3685		12	4205
	18	2050		18	2415		18	2806		18	3229		18	3695		18	4216
	24	2057		24	2423		24	2814		24	3238		24	3705		24	4227
	30	2064		30	2430		30	2822		30	3247		40	3714		30	4238
	36	2071		36	2438		36	2830		36	3256		36	3724		36	4250
	42	2078		42	2446		42	2839		42	3265		42	3734		42	4261
	48	2085		48	2455		48	2847		48	3274		48	3744		48	4272
	54	2092		54	2461		54	2855		54	3283		54	3754		54	4283
33	0	2100	38	0	2468	43	0	2863	48	0	3294	53	0	3764	58	0	4295
	6	2107		6	2476		6	2871		6	3301		6	3774		6	4306
	12	2114		12	2484		12	2880		12	3310		12	3784		12	4317
	18	2121		18	2491		18	2888		18	3319		18	3794		18	4329
	24	2128		24	2499		24	2896		24	3328		24	3804		24	4340
	30	2135		30	2507		30	2904		30	3337		30	3814		30	4352
	36	2143		36	2514		36	2913		36	3346		36	3824		36	4363
	42	2150		42	2522		42	2921		42	3355		42	3834		42	4375
	48	2157		48	2530		48	2929		48	3364		48	3844		48	4386
	54	2164		54	2537		54	2938		54	3373		54	3855		54	4398
34	0	2171	39	0	2545	44	0	2946	49	0	3382	54	0	3865	59	0	4409
	6	2179		6	2553		6	2954		6	3391		6	3875		6	4421
	12	2186		12	2560		12	2963		12	3401		12	3885		12	4433
	18	2193		18	2568		18	2971		18	3410		18	3896		18	4445
	24	2201		24	2570		24	2979		24	3419		24	3906		24	4456
	30	2208		30	2584		30	2988		30	3428		30	3916		30	4468
	36	2215		36	2592		36	2996		36	3437		36	3927		36	4480
	42	2222		42	2599		42	3005		42	3447		42	3937		42	4494
	48	2230		48	2607		48	3013		48	3456		48	3947		48	4504
	54	2237		54	2615		54	3022		54	3465		54	3958		54	4516

A TABLE of Meridional Parts.

Latitude. D.	M.	Meridional Parts.	Latitude. D.	M.	Meridional Parts.	Latitude. D.	M.	Meridional Parts.	Latitude. D.	M.	Meridional Parts.	Latitude. D.	M.	Meridional Parts.
60	0	4528	65	0	5179	70	0	5967	75	0	6972	80	0	8277
	6	4540		6	5194		6	5984		6	6095		6	8312
	12	4552		12	5208		12	6002		12	7018		12	8347
	18	4564		18	5222		18	6020		18	7042		18	8383
	24	4566		24	5237		24	6038		24	7066		24	8418
	30	4588		30	5251		30	6056		30	7089		30	8455
	36	4600		36	5265		36	6074		36	7114		36	8491
	42	4613		42	5280		42	6092		42	7138		42	8528
	48	4625		48	5295		48	6110		48	7162		48	8566
	54	4637		54	5309		54	6128		54	7187		54	8603
61	0	4650	66	0	5324	71	0	6147	76	0	7211	81	0	8742
	6	4662		6	5339		6	6165		6	7236		6	8780
	12	4674		12	5354		12	6184		12	7261		12	8819
	18	4687		18	5369		18	6202		18	7287		18	8859
	24	4699		24	5384		24	6221		24	7312		24	8899
	30	4712		30	5399		30	6240		30	7338		30	8939
	36	4725		36	5414		36	6259		36	7364		36	8980
	42	4737		42	5429		42	6278		42	7390		42	9021
	48	4750		48	5444		48	6297		48	7418		48	9063
	54	4763		54	5459		54	6316		54	7442		54	9105
62	0	4775	67	0	5475	72	0	6336	77	0	7469	82	0	9148
	6	4788		6	5490		6	6355		6	7495		6	9192
	12	4801		12	5505		12	6375		12	7522		12	9236
	18	4814		18	5521		18	6394		18	7550		18	9280
	24	4827		24	5537		24	6414		24	7577		24	9325
	30	4840		30	5552		30	6434		30	7605		40	9371
	36	4853		36	5568		36	6454		36	7633		36	9417
	42	4866		42	5584		42	6474		42	7661		42	9464
	48	4879		48	5600		48	6495		48	7889		48	9512
	54	4892		54	5615		54	6515		54	7717		54	9560
63	0	4905	68	0	5631	73	0	6535	78	0	7746	83	0	9609
	6	4919		6	5648		6	6556		6	7775		6	9659
	12	4932		12	5664		12	6577		12	7804		12	9709
	18	4945		18	5680		18	6598		18	7834		18	9760
	24	4959		24	5696		24	6618		24	7864		24	9812
	30	4972		30	5712		30	6640		30	7894		30	9865
	36	4986		36	5729		36	6661		36	7924		36	9918
	42	4999		42	5745		42	6682		42	7954		42	9973
	48	5013		48	5762		48	6704		48	7985			
	54	5026		54	5779		54	6725		54	7916			
64	0	5040	69	0	5795	74	0	6747	79	0	8048			
	6	5054		6	5812		6	6769		6	8079			
	12	5067		12	5829		12	6791		12	8111			
	18	5081		18	5846		18	6813		18	8148			
	24	5095		24	5863		24	6835		24	8176			
	30	5109		30	5880		30	6857		30	8209			
	36	5123		36	5897		36	6880		36	8242			
	42	5137		42	5914		42	6903		42	8275			
	48	5151		48	5932		48	6925		48	8309			
	54	5165		54	5949		54	6948		54	8343			

Prob.

A TABLE of Meridional Parts.

Latitude. D.	M.	Meridional Parts.	Latitude. D.	M.	Meridional Parts.	Latitude. D.	M.	Meridional Parts.	Latitude. D.	M.	Meridional Parts.	Latitude. D.	M.	Meridional Parts.	Latitude. D.	M.	Meridional Parts.
30	0	1888	35	0	2244	40	0	2623	45	0	3030	50	0	3475	55	0	39
	6	1895		6	2252		6	2631		6	3039		6	3484		6	39
	12	1902		12	2259		12	2638		12	3047		12	3493		12	39
	18	1909		18	2266		18	2646		18	3056		18	3503		18	40
	24	1916		24	2274		24	2654		24	3064		24	3512		24	40
	30	1923		30	2281		30	2662		30	3073		30	3522		30	40
	36	1930		36	2288		36	2670		36	3081		36	3531		36	40
	42	1937		42	2296		42	2678		42	3090		42	3540		42	40
	48	1944		48	2303		48	2686		48	3098		48	3550		48	40
	54	1951		54	2311		54	2694		54	3107		54	3559		54	40
31	0	1958	36	0	2318	41	0	2702	46	0	3116	51	0	3569	56	0	40
	6	1962		6	2325		6	2710		6	3124		6	3578		6	40
	12	1972		12	2333		12	2718		12	3132		12	3588		12	40
	18	1979		18	2340		18	2726		18	3143		18	3598		18	41
	24	1986		24	2348		24	2734		24	3150		24	3607		24	4
	30	1993		30	2355		30	2742		30	3159		30	3617		30	4
	36	2000		36	2363		36	2750		36	3168		36	3627		36	4
	42	2007		42	2370		42	2758		42	3176		42	3636		42	4
	48	2014		48	2378		48	2766		48	3185		48	3646		48	4
	54	2021		54	2385		54	2774		54	3194		54	3656		54	4
32	0	2028	37	0	2393	42	0	2782	47	0	3203	52	0	3665	57	0	41
	6	2035		6	2400		6	2790		6	3212		6	3675		6	41
	12	2043		12	2408		12	2798		12	3219		12	3685		12	42
	18	2050		18	2415		18	2806		18	3229		18	3695		18	42
	24	2057		24	2423		24	2814		24	3238		24	3705		24	42
	30	2064		30	2430		30	2822		30	3247		40	3714		30	42
	36	2071		36	2438		36	2830		36	3256		36	3724		36	42
	42	2078		42	2446		42	2839		42	3265		42	3734		42	42
	48	2085		48	2455		48	2847		48	3274		48	3744		48	42
	54	2092		54	2461		54	2855		54	3283		54	3754		54	42
33	0	2100	38	0	2468	43	0	2863	48	0	3294	53	0	3764	58	0	42
	6	2107		6	2476		6	2871		6	3301		6	3774		6	43
	12	2114		12	2484		12	2880		12	3310		12	3784		12	43
	18	2121		18	2491		18	2888		18	3319		18	3794		18	43
	24	2128		24	2499		24	2896		24	3328		24	3804		24	434
	30	2135		30	2507		30	2904		30	3337		30	3814		30	435
	36	2143		36	2514		36	2913		36	3346		36	3824		36	436
	42	2150		42	2522		42	2921		42	3355		42	3834		42	437
	48	2157		48	2530		48	2929		48	3364		48	3844		48	438
	54	2164		54	2537		54	2938		54	3373		54	3855		54	439
34	0	2171	39	0	2545	44	0	2946	49	0	3382	54	0	3865	59	0	440
	6	2179		6	2553		6	2954		6	3391		6	3875		6	442
	12	2186		12	2560		12	2963		12	3401		12	3885		12	443
	18	2193		18	2568		18	2971		18	3410		18	3896		18	444
	24	2201		24	2570		24	2979		24	3419		24	3906		24	445
	30	2208		30	2584		30	2988		30	3428		30	3916		30	446
	36	2215		36	2592		36	2996		36	3437		36	3927		36	448
	42	2222		42	2599		42	3005		42	3447		42	3937		42	449
	48	2230		48	2607		48	3013		48	3456		48	3947		48	450
	54	2237		54	2615		54	3022		54	3465		54	3958		54	451

A TABLE of Meridional Parts.

Latitude. D.	M.	Meridional Parts.	Latitude. D.	M.	Meridional Parts.	Latitude. D.	M.	Meridional Parts.	Latitude. D.	M.	Meridional Parts.	Latitude. D.	M.	Meridional Parts.
60	0	4528	65	0	5179	70	0	5967	75	0	6972	80	0	8377
	6	4540		6	5194		6	5984		6	6095		6	8312
	12	4552		12	5208		12	6002		12	7018		12	8347
	18	4564		18	5222		18	6020		18	7042		18	8383
	24	4566		24	5237		24	6038		24	7066		24	8418
	30	4588		30	5251		30	6056		30	7089		30	8455
	36	4600		36	5265		36	6074		36	7114		36	8491
	42	4613		42	5280		42	6092		42	7138		42	8528
	48	4625		48	5295		48	6110		48	7162		48	8566
	54	4637		54	5309		54	6128		54	7187		54	8603
61	0	4650	66	0	5324	71	0	6147	76	0	7211	81	0	8742
	6	4662		6	5339		6	6165		6	7236		6	8780
	12	4674		12	5354		12	6184		12	7261		12	8819
	18	4687		18	5369		18	6202		18	7287		18	8859
	24	4699		24	5384		24	6221		24	7312		24	8899
	30	4712		30	5399		30	6240		30	7338		30	8939
	36	4725		36	5414		36	6259		36	7364		36	8980
	42	4737		42	5429		42	6278		42	7390		42	9021
	48	4750		48	5444		48	6297		48	7418		48	9063
	54	4763		54	5459		54	6316		54	7442		54	9105
62	0	4775	67	0	5475	72	0	6336	77	0	7469	82	0	9148
	6	4788		6	5490		6	6355		6	7495		6	9192
	12	4801		12	5505		12	6375		12	7522		12	9236
	18	4814		18	5521		18	6394		18	7550		18	9280
	24	4827		24	5537		24	6414		24	7577		24	9325
	30	4840		30	5552		30	6434		30	7605		40	9371
	36	4853		36	5568		36	6454		36	7633		36	9417
	42	4866		42	5584		42	6474		42	7661		42	9464
	48	4879		48	5600		48	6495		48	7889		48	9512
	54	4892		54	5615		54	6515		54	7717		54	9560
63	0	4905	68	0	5631	73	0	6535	78	0	7746	83	0	9609
	6	4919		6	5648		6	6556		6	7775		6	9659
	12	4932		12	5664		12	6577		12	7804		12	9709
	18	4945		18	5680		18	6598		18	7834		18	9760
	24	4959		24	5696		24	6618		24	7864		24	9812
	30	4972		30	5712		30	6640		30	7894		30	9865
	36	4986		36	5729		36	6661		36	7924		36	9918
	42	4999		42	5745		42	6682		42	7954		42	9973
	48	5013		48	5762		48	6704		48	7985			
	54	5026		54	5779		54	6725		54	7916			
64	0	5040	69	0	5795	74	0	6747	79	0	8048			
	6	5054		6	5812		6	6769		6	8079			
	12	5067		12	5829		12	6791		12	8111			
	18	5081		18	5846		18	6813		18	8148			
	24	5095		24	5863		24	6835		24	8176			
	30	5109		30	5880		30	6857		30	8209			
	36	5123		36	5897		36	6880		36	8242			
	42	5137		42	5914		42	6903		42	8275			
	48	5151		48	5932		48	6925		48	8309			
	54	5165		54	5949		54	6948		54	8343			

Probl. I. *To find what* Meridional Parts *are contained in any* Difference *of* Latitude.

Let there be two Places, one in the *Latitude* of 32 deg. 25 min. North, and the other in the *Latitude* of 50 deg. North.

The *Meridional Parts* belonging to 50 deg. are	3475
The *Meridional Parts* belonging to 32 deg. 25 min. are	2058
Meridional Parts in 17 d. 35 m. the *Difference* of *Latitude*	1417

Which *Difference* are the *Meridional Parts* contained in the *Difference* of the two *Latitudes*.

This holds when the two given *Latitudes* are both North, or both South.

But if one *Latitude* be North, and the other South, then the Summ of the *Meridional Parts* of both *Latitudes* is the *Meridional Parts* anſwering to thoſe *Differences* of *Latitude*.

So if one Place be in 50 deg. of North *Latitude*, and the other in South *Latitude* 26 deg. the *Meridional Parts* anſwering to the *Difference* of theſe two *Latitudes* will be 5091.

The *Meridional Parts* anſwering to 50 d. of *Latitude* are	3475
The *Meridional Parts* anſwering to 26 d. of *Latitude* are	1616
Their Summ	5091

Which are the *Meridional Parts* contained between thoſe two *Latitudes*.

II. *To turn* Degrees *and* Minutes *of* Difference *of* Longitude *into* Meridional Parts.

This is performed by common *Multiplication*, in this manner: Multiply the *Degrees* of *Difference* of *Longitude* by 60, the Product is the *Meridional Parts* anſwering thereunto.

Let the *Degrees* of *Difference* of *Longitude* be 12; this multiplied by 60, produceth 720 for the *Meridional Parts* anſwering to 12 deg. of *Difference* of *Longitude*.

But if there be any odd *Minutes* joined with your *Degrees*, they muſt be added to the *Meridional Parts*: As,

Let the *Difference* of *Longitude* be 7 deg. 42 min. 7 multiplied by 60 produceth 420, to which add the 42 min. and it is 462, the *Meridional Parts* anſwering to 7 deg. 42 min. of *Difference* of *Longitude*.

Thus having ſhewed how to reduce *Degrees* of *Difference* of *Longitude* and *Latitude* into *Meridional Parts*, I will now proceed to the Solution of ſome *Problems* in *Sailing* by the True *Sea-Chart*, and that by the Doctrine of *Plain Triangles*.

III. *The* Latitudes *of two Places, and their* Difference *of* Longitude *given, to find the* Rumb *and* Diſtance.

In theſe following *Problems* I will make uſe of Mr. *Norwood's* Example of two Places, *viz.* the *Lizard*, lying in 50 deg. of North *Latitude*, and the *Somer Iſland*, (commonly called *Bermudas*) lying in the *Latitude* of 32 deg. 25 min. North. Then,

Fig. VI. In the *Triangle* A D B, let A repreſent the *Lizard*, and A B the *Parallel* of the *Latitude* thereof, *viz.* 50 deg.—— Let D repreſent the *Bermudas*, and D B the *Meridian* thereof. Then,

In the *Triangle* A D B there is given, (1.) D B, the *Difference* of *Latitude*, 17 deg. 35 min. which turned into *Meridional Parts*, are 1417 Parts. (2.) A B, the *Difference* of *Longitude*, 70 deg. which (turned into *Minutes* or *Miles*) makes 4200: Which two Sides (and the Right Angle) being given, we may find,

I. The *Rumb* A D B,

By the IV. *Caſe* of *Right-angled Plain Triangles*,

As the *Difference* of *Latitude* D B, (17 d. 35 m.) in Parts, 1417.	Co-Ar.	6.84863
Is to the *Difference* of *Longitude* A B, (70 deg.) in Miles, 4200		3.62325
So is the *Radius*, 90 deg.		10.
To the *Tangent* of A D B the *Rumb*, 71 deg. 21 min.		10.47188

So

So that the *Course* from the *Bermudas* to the *Lizard* is E N E, 3 deg. 51 m. Easterly; and from the *Lizard* to *Bermudas* W S W, 3 deg. 51 min. Westerly,

II. For the *Distance* in the *Rumb.*

By the II. *Case.* But first,

Reduce the *Difference* of *Latitude*, 17 deg. 35 min. into Miles, by multiplying them by 60, which makes 1055 Miles. Then,

As the *Co-sine* of the *Rumb* D A B, 18 deg. 39 min.	Co. Ar. 0.49514
Is to the *Difference* of *Latitude*, D B, in Miles, 1055.	3.02325
So is the *Radius*, 90 deg.	10.
To the *Distance* A D, 3299 Miles	x3.51839

Which is almost 1100 Leagues.

Note, In this or the like Cases, whensoever we speak of the *Distance* of two Places, is meant their *Distance* measured in the *Rumb.*

IV. *The* Latitudes *of two Places, and their* Distance *given, to find the* Rumb, *and* Difference *of* Longitude.

Suppose I sail from the *Lizard* at A, in the *Latitude* of 50 deg. upon some Point to the Westward, 3299 Miles, and then find my self in the *Latitude* of 32 d. 25 m. I would know upon what *Course* I have made my Way good, and how much I have altered my *Longitude.*

In the *Triangle* A D B there is given, (1.) A D, the *Distance* failed, 3299 Miles. (2.) D B, the *Difference* of *Latitudes* in Miles 1055, by which I may find the *Rumb* and *Difference* of *Longitude.*

I. For the *Rumb.*

By the V. *Case* of *Right-angled Plain Triangles.*

As the *Distance* sailed, A D, 3299.	Co. Ar. 6.48161
To the *Radius*, 90 deg.	10.
So is the *Difference* of *Latitude*, D B, 1055 Miles	3.02325
To the *Co-sine* of the *Rumb* D A B, 18 d. 39 m.	x9.50486

That is, W S W, 3 deg. 51 min. Westerly.

II. For the *Difference* of *Longitude.*

Find (by *Prob.* I.) what *Meridional Parts* are contained in the *Difference* of *Latitude* 17 deg. 35 min. and they will be 1417 *Parts.* Then,

As the *Radius*, 90 deg.	10.
To the *Difference* of *Latitude* in Parts, D B, 1417	3.15137
So is the *Tangent* of the *Rumb* A D B, 71 d. 21 m.	10.47188
To the *Difference* of *Longitude* A B, in Parts 4200	x3.62325

Which Parts reduced into Degrees, (by dividing them by 60,) the *Quotient* is 70 deg. for the *Difference* of *Longitude* required.

V. *By the* Rumb, *and* Latitude *of two Places given, to find their* Distance *and* Difference *of* Longitude..

Admit I sail from the *Lizard* at D, (being in the *Latitude* of 50 deg.) W S W, 3 deg. 51 min. Westerly, till I find my self at A, in the *Latitude* of 32 deg. 25 min. I demand how far I have sailed, and how much I have altered my *Longitude.*

The *Distance* is found as in the Latter Part of *Probl.* III. The 17 deg. 35 min. converted into Miles is 1055 Miles. Say then,

As the *Co-sine* of the *Rumb* D A B, 13 d. 39 m.	Co. Ar. 0.48514
To the *Difference* of *Latitude* D B in Miles, 1055	3.02325
So is the *Radius*, 90 deg.	10.
To the *Distance* A D in Miles, *viz.* 3299	x3.51839

Thus

Thus for the *Distance*: And for the *Difference* of *Longitude*, that may be found as in the Latter Part of *Probl.* II. thus:

As the *Radius*,
Is to the *Difference* of *Latitude* in *Meridional Parts*;
So is the *Tangent* of the *Rumb*,
To the *Difference* of *Longitude* in Minutes.
Which divided by 60, gives the *Difference* of *Longitude* in *Degrees*, *viz.* 70 deg.

VI. *By the* Difference *of* Longitude, *the* Rumb, *and one* Latitude, *to find the other* Latitude *and the* Distance.

Admit I sail from the *Lizard* at D, (being in the *Latitude* of 50 deg.) W S W, 3 deg. 51 min. Westerly, till I have altered my *Longitude* 70 deg. how much have I depressed the *Pole*, and how far am I from the *Lizard*?

First, Reduce the *Difference* of *Longitude*, A B, 70 deg. into *Minutes*, by multiplying them by 60, it makes 4200: Then say,

As the *Tangent* of the *Rumb* A D B, 71 deg. 21 min.	Co. Ar. 9.52829
To the *Difference* of *Longitude* A B in Parts, 4200	3.62325
So is the *Radius*, 90 deg.	10.
To the *Difference* of *Latitude* of *Latitude* D B in Parts, 1417	x3.15154

Now the *Meridional Parts* answering to 50 deg. of *Latitude* are 3475, from which subtracting 1417, (the Parts here found,) there remains 2058; which sought in the Table, against it you will find 32 deg. 25 min. which is the *Latitude* of the Place to which I am come; so that the *Difference* of *Latitude* is 17 deg. 35 min.

Secondly, For the *Distance*,

Having already the *Rumb* and *Difference* of *Latitude*, the *Distance* may be found as in the III. and V. *Problems*, in this manner.

As the *Co-sine* of the *Rumb* D A B, 18 d. 39 m.	Co. Ar. 0.49514
To the *Difference* of *Latitude* D B, 1055 Miles	3.02325
So is the *Radius*, 90 deg.	10.
To the *Distance* A D, 3299 Miles	x3.51839

VII. *The* Rumb, *the* Distance, *and one* Latitude *given*, *to find the other* Latitude, *and the* Difference *of* Longitude.

Suppose I sail W S S, 3 deg. 1 min. Westerly, 3299 Miles, and then find my self in the *Latitude* of 32 deg. 25 min. I demand the *Latitude* of the Place from which I came, and the *Difference* of *Longitude* between That and This.

First, For the *Difference* of *Latitude*,

As the *Radius*, 90 deg.	10.
Is to the *Distance* sailed, A D, 3299 Miles	3.51838
So is the *Co-sine* of the *Rumb* D A B, 18 d. 39 m.	9.50486
To the *Difference* of *Latitude* D B, 1055 Miles	x3.02324

Which 1055 Miles converted into Degrees, is 17 deg. 35 min. the *Difference* of *Latitude* required, which added to 32 deg. 25 min. makes 50 deg. for the *Latitude* of the First Place.

The *Difference* of *Longitude* is found as before in the IV. *Problem*, thus:

As the *Radius*,
To the *Difference* of *Latitude* in *Meridional Parts*;
So is the *Tangent* of the *Rumb*,
To the *Difference* of *Longitude* in Minutes.
And thus the *Difference* of *Longitude* will be found, as in this Example, to be 70 deg.

VIII. *To*

VIII. *To convert the* Difference *of* Longitude *found in any* Parallel, *in* Degrees *and* Minutes, *into* Miles.

Admit there be two Places, A and B, both in the *Parallel* of 50 deg. of *Latitude*, which differ in *Longitude* 70 deg. I demand the *Distance* of those two Places.

It is to be understood, that the *Minutes* of *Longitude* in any *Parallel* are in proportion to the *Distance* in *Miles*, as the *Equinoctial* is to the *Parallel*; or, as the *Semidiametre* of the *One* is to the *Semidiametre* of the *Other*. That is,

As the *Radius*, 90 deg.	10.
Is to the *Co-sine* of the *Latitude*, 40 deg.	9.80807
So is the *Difference* of *Longitude* in Miles, 4200	3.62325
To the *Distance* in that *Parallel* 2700 Miles	x3.43132

By *Protraction*.

Let it be required to protract the two Places before mentioned, one in the *Latitude* of 50 deg. the other in the *Latitude* of 32 deg. 25 min. and differing in *Longitude* 70 deg. both by the *Plain*, and by the *True Sea Charts*.

First, Draw a Right-line, E Æ, representing the *Parallel* of the *Latitude* of the *Lizard*, 32 deg. 25 min. and upon it set 70 deg. the *Difference* of *Longitude* (in Miles 4200) from Æ to E.

Secondly, From Æ let fall a Perpendicular Æ C, representing the *Meridian* of *Bermudas*: And because the *Difference* of *Latitudes* is 17 deg. 35 min. and the *Meridional Parts* answering thereunto are 1417, set them from Æ to C, and draw the Line E C; so shall you have constituted a Right-angled Triangle Æ E C.

Again, Reduce the 17 deg. 35 min. the *Difference* of *Latitude*, into Miles, by multiplying of them by 60, and they make 1055, which set from C to A, and through A draw the Line A B Parallel, and of the same length with E Æ, (*viz.* 4200 Miles) and draw the Line B C, constituting another Right-angled Triangle A B C.

Now is C *Bermudas*, and B the *Lizard*, distant 4329 Miles, according to the *Plain Chart*; but C D the *Distance* 3299 Miles, according to the *True Chart*:—The *Difference* 1030 Miles.

And now is B C the *Rumb-line* between the two Places, according to the *Plain Chart*; but C E the *Rumb-line*, according to the *True Chart*; and the Angle B C A, 75 deg. 53 min. is the *Course*, according to the *Plain Chart*; but the Angle E C Æ, 71 deg. 21 min. is the *Course* according to the *True Chart*, differing 4 deg. 32 min.

Also, E Æ is the true *Difference* of *Longitude*, and A D the true *Meridian Distance* or *Departure*.

In this manner may all the other *Problems* before Calculated be Protracted; but this one may suffice, the *Protraction* differing nothing from that of the *Plain Chart*, only you must use the *Proper Difference* of *Longitude* and *Latitude*, in stead of the other.

PROBLEMS of SAILING
According to
MERCATOR's Projection,
Trigonometrically Performed, and also wrought upon the *Chart* it self.

With a *Parallel* between the Plain and True Sea-Chart.

PROBL. I. *How to make a* Sea-Chart *(both* General *and* Particular) *according to* Mercator*'s Projection.*

A *Sea-Chart*, according to this *Projection*, may be made *General*, from the *Equinoctial* towards either of the *Poles*; or *Particular*, for any one designed *Voyage* between any two *Parallels* of *Latitude*; both which are to be made by help of the following *Table*, which is fitted for dividing of a *Meridian Line* (or *Scale*) upon a *Ruler*, as Mr. *Gunter* hath taught how to doe: And such a *Meridian Scale* may be conveniently set upon such a *Ruler*, as is before described, *Lib.* 3. *Part* 2. of *Practical Astronomy*. But let it suffice here to shew how to Project a *Sea-Chart* by the following Table.

A TABLE
For the Dividing the
MERIDIANS
IN A
True Sea-Chart,
According to Mr. *Wright*'s (vulgarly called *Mercator*'s) Projection.

A TABLE

A TABLE for Dividing the Meridians *in a True* Sea-Chart.

D.	M.	D. par.	D.	M.	D. par.	D.	M.	D. par.	D.	M.	D. par.	D.	M.	D. par.	D.	M.	D. par.	D.	M.	D. par.	D.	M.	D. par.
0	0	.00	6	0	6.01	12	0	12.09	18	0	18.30	24	0	24.73	30	0	31.47	36	0	38.63	42	0	46.36
	6	.10		6	6.11		6	12.19		6	18.41		6	24.84		6	31.58		6	38.76		6	46.50
	12	.20		12	6.21		12	12.29		12	18.51		12	24.95		12	31.70		12	28.88		12	46.63
	18	.30		18	6.31		18	12.39		18	18.62		18	25.06		18	31.82		18	39.00		18	46.80
	24	.40		24	6.41		24	12.49		24	18.72		24	25.17		24	31.93		24	39.12		24	46.90
	30	.50		30	6.51		30	12.60		30	18.83		30	25.28		30	32.05		30	39.25		30	47.04
	36	.60		36	6.50		36	12.70		36	18.93		36	25.39		36	32.17		35	39.37		36	47.17
	42	.70		42	6.71		42	12.81		42	19.04		42	25.50		42	32.28		42	39.50		42	47.31
	48	.80		48	6.82		48	12.91		48	19.15		48	25.61		48	32.41		48	39.63		48	47.44
	54	.90		54	6.92		54	13.01		54	19.25		54	25.72		54	32.52		54	39.75		54	47.58
1	0	1.00	7	0	7.02	13	0	13.11	19	0	19.36	25	0	25.83	31	0	32.63	37	0	39.88	43	0	47.72
	6	1.10		6	7.12		6	13.21		6	19.45		6	25.94		6	32.75		6	40.00		6	47.86
	12	1.20		12	7.22		12	13.32		12	19.56		12	26.05		12	32.87		12	40.13		12	47.99
	18	1.30		18	7.32		18	13.42		18	19.67		18	26.16		18	32.98		18	40.25		18	48.13
	24	1.40		24	7.42		24	13.52		24	19.78		24	26.27		24	33.10		24	40.38		24	48.27
	30	1.50		30	7.52		30	13.62		30	19.89		30	26.38		30	33.21		30	40.50		30	48.40
	36	1.60		36	7.62		36	13.73		36	19.99		36	26.50		36	33.34		36	40.63		36	48.54
	42	1.70		42	7.72		42	13.83		42	20.10		42	26.60		42	33.45		42	40.76		42	48.68
	48	1.80		48	7.82		48	13.93		48	20.21		48	26.72		48	33.57		48	40.88		48	48.82
	54	1.90		54	7.92		54	14.04		54	20.31		54	26.83		54	33.69		54	41.01		54	48.96
2	0	2.00	8	0	8.03	14	0	14.14	20	0	20.42	26	0	26.94	32	0	33.80	38	0	41.14	44	0	49.08
	6	2.10		6	8.13		6	14.24		6	20.52		6	27.05		6	33.92		6	41.26		6	49.23
	12	2.20		12	8.23		12	14.35		12	20.63		12	27.16		12	34.04		12	41.42		12	49.37
	18	2.30		18	8.33		18	14.45		18	20.74		18	27.27		18	34.16		18	41.52		18	49.51
	24	2.40		24	8.43		24	14.55		24	20.84		24	27.39		24	34.28		24	41.65		24	49.65
	30	2.50		30	8.53		30	14.66		30	20.95		30	27.50		30	34.40		30	41.77		32	49.79
	36	2.60		36	8.63		36	14.76		36	21.05		36	27.61		36	34.52		36	41.20		36	49.93
	42	2.70		42	8.73		42	14.86		42	21.16		42	27.72		42	34.63		42	42.03		42	50.07
	48	2.80		48	8.83		48	14.96		48	21.29		41	27.83		48	34.75		48	42.16		48	50.22
	54	2.90		54	8.94		54	15.07		54	21.37		54	27.95		54	34.87		54	42.29		54	50.36
3	0	3.00	9	0	9.04	15	0	15.17	21	0	21.49	27	0	28.06	33	0	34.99	39	0	42.41	45	0	50.50
	6	3.10		6	9.14		6	15.27		6	21.59		6	28.17		6	35.11		6	42.54		6	50.64
	12	3.20		12	9.24		12	15.38		12	21.70		12	28.28		12	35.23		12	42.67		12	50.78
	18	3.30		18	9.34		18	15.49		18	21.81		18	28.40		18	35.35		18	42.80		18	50.92
	24	3.40		24	9.44		24	15.59		24	21.91		24	28.51		24	35.47		24	42.93		24	51.06
	30	3.50		30	9.54		30	15.69		30	22.02		30	28.62		30	35.59		30	43.06		30	51.21
	36	3.60		36	9.64		36	15.79		36	22.13		36	28.73		36	35.71		36	43.19		36	51.35
	42	3.70		42	9.75		42	15.90		42	22.24		42	28.85		42	35.83		42	43.32		42	51.50
	48	3.80		48	9.85		48	16.00		48	22.34		48	28.96		48	35.95		48	43.45		48	51.64
	54	3.90		54	9.95		54	16.10		54	22.45		54	29.07		54	36.07		54	43.58		54	51.78
4	0	4.00	10	0	10.05	16	0	16.21	22	0	22.56	28	0	29.18	34	0	36.19	40	0	43.71	46	0	51.93
	6	4.10		6	10.15		6	16.32		6	22.67		6	29.30		6	36.3		6	43.84		6	52.07
	12	4.20		12	10.25		12	16.42		12	22.77		12	29.41		12	36.43		12	43.97		12	52.21
	18	4.30		18	10.35		18	16.52		18	22.88		11	29.52		18	36.55		18	44.10		18	52.36
	24	4.40		24	10.46		24	16.63		24	22.99		24	29.64		24	36.67		24	44.23		24	52.50
	30	4.50		30	10.56		30	16.73		30	23.10		30	29.75		30	36.79		30	44.37		30	52.65
	36	4.60		36	10.66		36	16.84		36	23.21		36	29.87		36	36.91		36	44.50		36	52.79
	42	4.70		42	10.76		42	16.94		42	23.32		42	29.98		42	37.04		42	44.65		42	53.94
	48	4.80		48	10.86		48	17.05		48	23.43		48	30.09		48	37.16		48	44.76		48	53.08
	54	4.91		54	10.96		54	17.15		54	23.53		54	30.20		54	37.28		54	44.89		54	53.23
5	0	5.01	11	0	11.07	17	0	17.25	23	0	23.64	29	0	30.32	35	0	37.40	41	0	45.02	47	0	53.38
	6	5.11		6	11.17		6	17.36		6	23.75		6	30.44		6	37.52		6	45.16		6	53.52
	12	5.21		12	11.27		12	17.46		12	23.86		12	30.55		12	37.64		12	45.29		12	53.67
	18	5.31		18	11.37		18	17.56		18	23.97		18	30.67		18	37.77		18	45.42		18	53.82
	24	5.41		24	11.47		24	17.67		24	24.07		24	30.78		24	37.89		24	45.56		24	53.97
	30	5.51		30	11.57		30	17.77		30	24.18		30	30.90		30	38.02		30	45.69		30	54.11
	36	5.61		36	11.68		36	17.88		36	24.30		36	31.01		36	38.14		36	45.82		36	54.26
	42	5.71		42	11.78		42	17.99		42	24.40		42	31.13		42	38.26		42	45.99		42	54.41
	48	5.81		48	11.88		48	18.09		48	24.51		48	31.24		48	38.39		48	46.06		48	54.56
	54	5.90		54	11.98		54	18.20		54	24.62		54	31.36		52	38.51		54	46.22		54	54.71

A TABLE *for Dividing the* Meridians *in a True* Sea-Chart.

D. M.	D. par.	D. M.	D. par.	D. M.	D. par.	D. M.	D. par.	D. M.	D. par.	D. M.	D. par.	D. M.	D. par.
48 0	54.86	54 0	64.41	60 0	75.45	66 0	88.72	72 0	105.58	78 0	129.07	84 0	168.94
6	55.01	6	64.58	6	75.65	6	88.97	6	105.90	6	119.56	6	169.90
12	55.16	12	64.75	12	75.85	12	89.22	12	106.13	12	130.06	12	170.90
18	55.31	18	64.92	18	76.05	18	89.47	18	106.55	18	130.54	18	171.90
24	55.46	24	65.09	24	76.26	24	89.71	24	106.89	24	131.03	24	172.90
30	55.61	30	65.27	30	76.46	30	89.97	30	107.22	30	131.53	30	173.94
36	55.76	36	65.44	36	76.67	36	90.22	36	107.51	36	132.04	36	174.99
42	55.91	42	65.61	42	75.87	42	90.47	42	107.69	42	132.54	42	176.06
48	56.06	48	65.78	48	77.07	48	90.72	48	108.23	48	133.05	48	177.16
54	56.21	54	65.96	54	77.28	54	90.98	54	108.66	54	133.57	54	178.27
49 0	56.37	55 0	66.13	61 0	77.49	67 0	91.23	73 0	108.91	79 0	134.09	85 0	179.41
6	56.52	6	66.30	6	77.69	6	91.49	6	109.25	6	134.60	6	180.57
12	56.68	12	66.48	12	77.99	12	91.75	12	109.59	12	135.19	12	181.75
18	56.83	18	66 66	18	78.11	18	92.00	18	109.94	18	135.68	18	182.96
24	56.98	24	66.83	24	78.37	24	92.26	24	110.29	24	136.23	24	184.19
30	57.13	30	67.01	30	78.52	30	92.52	30	110.64	30	136.77	30	185.45
36	57.29	36	67.19	36	78.74	36	92.78	36	110.96	36	137.32	36	186.74
42	57.44	42	67.36	42	78.95	42	93.05	42	111.35	42	137.88	42	188.06
48	57.60	48	67.54	48	79.16	48	93.31	48	111.70	48	138.44	48	189.41
54	57.74	54	67.72	54	79.37	54	93.58	54	112.06	54	139.01	54	190.79
50 0	57.91	56 0	67.90	62 0	79.58	68 0	93.84	74 0	112.43	80 0	139.58	86 0	192.21
6	58.06	6	68.07	6	79.79	6	94.21	6	112.79	6	140.16	6	193.66
12	58.22	12	68.26	12	80.01	12	94.38	12	113.16	12	140.75	12	195.15
18	58.38	18	68.44	18	80.22	18	94.65	18	113.52	18	141.34	18	196.68
24	58.53	24	68.62	24	80.41	24	94.92	24	113.89	24	141.93	24	198.25
30	58.69	30	68.80	30	80.66	30	95.19	30	114.27	30	142.54	30	199.86
36	58.85	36	68.98	36	80.87	36	95.47	36	114 64	36	143.14	36	201.53
42	59.00	42	69.16	42	81.09	42	95.74	42	115.02	42	143.76	42	203.24
48	59.16	48	69.34	48	81.51	48	96.02	41	115.40	48	144.38	48	205.00
54	59.32	54	69.53	54	81.33	54	96.29	54	115.79	54	145.01	54	206.82
51 0	59.48	57 0	69.71	63 0	81.75	69 0	96.57	75 0	116.17	81 0	145.65	87 0	208.70
6	59.64	6	69.89	6	81.97	6	96.85	6	116.56	6	146.29	6	210.65
12	59.80	12	70.08	12	82.19	12	97.11	12	116.95	12	146.94	12	212.67
18	59.96	18	70.26	18	82.42	18	97.42	18	117.34	18	147.60	18	214.74
24	60.12	24	70.45	24	82.63	24	97.70	24	117.73	24	148.26	24	216.90
30	60.28	30	70.64	30	82.86	30	97.98	30	118.13	30	148.93	30	219.16
36	60.44	36	70.82	36	83.08	36	98.27	36	118.53	36	149.61	36	221.50
42	60.60	42	71.01	42	83.31	42	98.56	42	118.94	42	150.30	42	223.94
48	60.76	48	71.19	48	83.53	48	98.85	48	119.34	48	151.00	48	226.48
54	60.92	54	71.48	54	83.76	54	99.14	54	119.75	54	151.71	54	229.15
52 0	61.09	58 0	71.57	64 0	83.99	70 0	99.43	76 0	120.17	82 0	152.42	88 0	231.95
6	61.25	6	71.76	6	84.22	6	99.72	6	121.58	6	153.14	6	234.89
12	61.41	12	71.95	12	84.45	12	100.01	12	121.00	12	153.88	12	237.99
18	61.57	18	72.14	18	84.68	18	100.31	11	121.40	18	154 62	18	241.20
24	61.74	24	72.33	24	84.91	24	100.61	24	121.84	24	155.37	24	244.74
30	61.90	30	72.52	30	85.14	30	100.91	30	122.27	30	156.13	30	248.44
36	62.07	36	72.71	36	85.37	36	101.21	36	122.70	36	156.90	36	252.40
42	62.23	42	72.90	42	85.60	42	101.51	42	123.13	42	157.58	42	256.65
48	62.40	48	73.10	48	85.14	48	101.81	48	123.57	48	158.48	48	261.24
54	62.56	54	73.29	54	86.07	54	102.12	54	124.01	54	159.28	54	266.23
53 0	62.73	59 0	73.49	65 0	86.31	71 0	102.43	77 0	124.45	83 0	160.09	89 0	271.70
6	62.90	6	73.68	6	86.55	6	102.73	6	124.90	6	160.92	6	277.75
12	63.06	12	73.87	12	86.79	12	103.04	12	125.35	12	161.76	12	284.51
18	63.23	18	74.07	18	87.03	18	103.35	18	125.80	18	162.61	18	292.19
24	63.40	24	74.27	24	87.27	24	103.67	24	126.26	24	163.47	24	301.06
30	63.57	30	74.46	30	87.51	30	103.98	30	125.72	30	164.35	30	311.56
36	63.73	36	74.66	36	87.75	36	104.30	36	127.18	36	165.24	36	324.45
42	63.90	42	74.86	42	87.99	42	104.62	42	127.65	42	165.14	42	341.16
48	64.07	48	75.06	48	88.23	48	104.94	48	128.12	48	167.06	48	365.04
54	64.24	54	75.26	54	88.48	54	105.26	54	128.60	54	167.99	54	408.01

I. The

I. *The Use of the Table in making a* General Sea-Chart *according to* Mercator's *Projection.*

FOR the manner of Division of the *Parallels* of *Longitude* upon the *Æquator*, let the *Æquator* Æ æ be drawn, and divided and crossed with *Parallel Meridians*, in all respects as in the *Plain Sea-Chart*: But for the dividing the *Meridians* you must have recourse to the following *Table*, and work in this manner. Fig. VIII.

Example 1. To draw the *Parallel* of 10 deg of *Latitude* from the *Equinoctial.*

Look in the Table for 10 deg. against which you shall find 10.05; this Number being taken out of the *Diagonal Scale* from which your *Equinoctial* Æ æ was divided, (or from the *Equinoctial* it self, it being so divided,) and set them upon the *Meridians* Æ P and æ S, from Æ to 10, and from æ to 10, and draw the Line 10 10 for the *Parallel* of 10 deg. of *Latitude* from the *Equinoctial*, either Northward or Southward.

Example 2. Let it be required to draw the *Parallel* of 40 deg. of *Latitude* from the *Equinoctial.*

Look into the Table for 40 deg. and against it you shall find 43.71 Parts, which take from the same *Diagonal Scale*, and set them upon the *Meridians* Æ P and æ S, from Æ to 40, and from æ to 40, and draw the Line 40 40 for the *Parallel* of 40 d. of *Latitude.*

Example 3. To describe the *Parallel* of 55 deg. of *Latitude.*

Look in the Table for 55 deg. against which you find 66.13, which taken out of the *Scale*, (or divided *Equinoctially*) it will reach from Æ to F, and from æ to E; so the Line F E being drawn, it shall be the *Parallel* of 55 deg of *Latitude*: And so for any other.

II. *The Use of the foregoing Table in making a* Particular Sea-Chart, *according to* Mercator's *Projection.*

TO make a *Particular Sea Chart* according to this *Projection*, first, draw the Line E F, serving for the First *Meridian*, and cross it with two *Parallels*, F G and E H, the one at the upper, the other at the lower end of the *Chart*, which may serve for the extreme *Parallels* of *Latitude* between which your *Navigation* will extend. Fig. IX.

Then consider at what *Latitude* the *Chart* is to begin and end; so this *Chart* here intended is between the *Latitudes* of 49 deg. and 57 deg. I therefore look into the Table, and find that 49 deg. of *Latitude* must be drawn at 56.37 Parts, and 57 deg. of *Latitude* at 69.71 Parts of the *Equinoctial*: Subtract 56.37 from 69.71, the Remainder will be 13.34, which is the *Meridional Distance* between the *Latitude* of 49 deg. and 57 deg. This done, take the Line E F in your Compasses, and measuring it upon a *Diagonal Scale*, you will find it to contain 12.75. Then say by the Rule of Proportion;

As 13.34, the *Meridional Distance* between the two *Latitudes*,
Is to 1000;
So is 12.75, the *Meridional Distance* between the two *extreme Latitudes*,
To 0.92, the *Parallel Distance* of the *Meridians.*

Wherefore, take 0.92 out of the same *Diagonal Scale* upon which you measured the Line E F, and with that Extent set off the other *Meridians* at both ends of the *Chart*, at 1, 2, 3, &c. and through those Points draw the *Meridians* 1, 1,—2, 2,—3, 3, parallel to the first *Meridian* E F, and number them with 1, 2, 3, &c. and divide each Space between 1 and 2, &c. into 10 or 100 Equal Parts; for it is supposed every of them to be divided into 1000 Equal Parts.

The *Meridians* being drawn, and the *Parallels* of the two *extreme Latitudes* divided, as is before said, proceed we now to prick down the other intermediate *Parallels* of *Latitude*, as followeth.

Look in the Table for 49 deg. against which is 56.37: Also look for 50 deg. against which is 57.91, their Difference is 1.54; which taken out of the divided *Parallel* of 49 deg. E H, will reach upon the *Meridians* E F and H G, from 49 to 50: so the Line 50 50 shall be the *Parallel* of 50 deg. of *Latitude* from the *Equinoctial.*

Then for the *Parallel* of 51 deg.

The Number against 51 deg. is	59.48
From which subtract the Merid. Distance of 49 deg.	56.37
The Remainder is	3.11

Which taken out of the divided Parallel of 49 deg. will reach upon the *Meridians* E F and H G to 51 and 51; so the Line 51 51 being drawn, shall be the Parallel of 51 deg. of *Latitude* from the *Equinoctial*: And so, by continual subtracting of 56.37 (the *Meridional Distance* of the lesser given *Latitude* 49 deg.) from the *Meridional Distance*, against every Degree of *Latitude* in the *Table*, they shall give Points whereby to prick down all the Parallels beyond 49 deg. towards either *Pole*: As in this little *Table* for this *Chart*.

From the *Meridional Distance* of (D.) *Viz.* Subtract 56.369, the *Meridional distance* of 49 deg. of *Latitude*, the remainder Shall be the *Distance* of the respective Parallels of *Latitude* upon the First *Meridian* from E and H, towards F and G.

D.	Viz.	Remainder
50	57.909	1.540
51	59.481	3.112
52	61.088	4.719
53	62.730	5.361
54	64.412	8.043
55	66.134	9.765
56	67.900	11.531
57	69.712	13.343

For the Sub-divisions of these Degrees of the *Meridian* they may be divided each of them into equal Parts, as the Divisions at the top and bottom of the *Chart* ought to be; but the Degrees of the *Meridian*, as they grow higher, they ought still to grow greater. But the difference is so small, that it cannot produce any considerable Error, though the Sub-divisions be all made equal between Degree and Degree. You may therefore divide them either into 60 Minutes or *English* Miles, or into 20 Leagues, or into 100 parts of Degrees, as you shall best like of.

Your *Chart* being thus prepared, I will now come to shew you how to resolve several *Problems* upon it.

II. *To find how many Leagues do answer to one Degree of* Longitude *in every several* Latitude.

Upon the two edges of your *Protracting Quadrant* there are two Lines, the one divided into 20, the other into 60 equal parts.

Take therefore the least distance from the Complement of the Parallel's distance from the *Æquator*, (or the Complement of the given *Latitude*:) this distance being measured upon the edge that is divided into 20, shall shew you what number of Leagues make one Degree of *Longitude* in that Parallel of *Latitude*. And the same Distance, being measured upon the other edge that is divided into 60, will give so many of our Miles, or so many Minutes of the *Æquinoctial*, or any other great Circle, as are answerable to one Degree of *Longitude* in that *Latitude*.

Example. Let it be required to find how many Leagues do answer to one Degree of *Longitude* in the *Latitude* of 18 deg. 12 min.

Set one Foot of your *Compasses* in 71 deg. 48 min. the Complement of the given *Latitude*, and with the other take the nearest Distance to the side of the *Quadrant* which is divided into 20: that Distance, measured upon the Line 20, will reach from the beginning thereof to 19: and so many Leagues do answer to one Degree of *Longitude* in the *Latitude* of 18 deg. 12 min.

Or, if you take the least Distance from 18 deg. 12 min. the *Latitude* it self, in the Limb of the *Quadrant*, to that edge which is divided into 60, that Distance will also reach to 19 upon the Line 20, as before.

And the same Distance, being measured upon the Line 60 of the *Quadrant*, will give you 57 parts: and so many Minutes of the *Æquator* are answerable to one Degree of *Longitude* in the Parallel of 18 deg. 12 min. of *Latitude*.

So likewise in the *Latitude* of 25 deg. 15 min. if you take the least Distance from the Complement thereof, or from the *Latitude* it self, to the edges of the *Quadrant*, you shall find that Distance to reach 18 in the Line of 20: and so many Leagues do answer to one Degree of *Longitude* in the *Latitude* of 25 deg. 15 min. or unto 54 in the Line of 60: and so many Minutes of the *Æquator* do answer to one Degree of *Longitude* in that Parallel of *Latitude*.

The Analogie or Proportion is,

As the *Radius*,	10.
Is to the Co-Sine of the *Latitude* 64 deg. 45 min.	9.95638
So is 20 Leagues,	1.30103
To 18 Leagues,	11.25741
And	
So is 60 Minutes or Miles,	
To 54 Minutes or Miles.	

III. *By the* Latitude *of two Places and their Distance, to find the* Rumb.

The Analogie or Proportion.

As the *Distance* upon the *Rumb*, 6 deg. *Mer. Parts* 361,	2.55751
Is to the *Radius*, 90 deg.	10.
So is the *Difference* of *Latitude*, 5 deg. *Mer. Parts* 300,	12.47712
To the Co-Sine of the Rumb, 56 deg. 15 min.	9.91961

Thus if the Places given were one in the *Latitude* of 50 deg. and the other in the *Latitude* of 55 deg. and the *Distance* upon the *Rumb* 6 deg. or 120 Leagues; the *Rumb* leading from one to the other will be found to be the third from the *Meridian*, namely N E by N. 33 deg. 45 min.

Upon the Chart.

LET A represent the Place in the *Latitude* of 50 deg. and C that in 55 deg. whose *Distance* from A to C is 6 deg. Take 6 deg. out of the *Meridian-line*, by setting one Foot as much below the lesser *Latitude* as above the greater, which will be from K in the *Latitude* of 49½ deg. to L in the *Latitude* of 55½; either of which are half a Degree above and under the two given *Latitudes*. Take this *Distance* K L in your *Compasses*, and setting one foot in A, (the lesser *Latitude*) with the other cross the Parallel of the greater *Latitude* 55 deg. in the Point C, and draw a Right-Line from A to C. So shall the quantity of the *Angle* B A C, being found, (either by your *Chord* or *Quadrant*,) shew you the Inclination of the *Rumb* to the *Meridian* to be 33 deg. 45 min. the N E by N. Point.

Note, *That in the Propositions following, the Difference of* Longitude *must always be taken out of the Æ*quator, *and measured thereupon also. But the Difference of* Latitude *and Distance upon the* Rumb *must always be measured upon, and taken out of the* Meridian-Line *of your* Chart. *And hereafter I shall call them the proper Difference, and proper Distance.*

IV. *The* Longitude *and* Latitude *of two Places being given to find the* Rumb.

The Analogie or Proportion.

As the *Proper Difference* of *Latitude* 5 deg. *Mer. Parts* 493,	2.69285
Is to the *Radius*, 90 deg.	10.
So is the *Difference* of *Longitude* 5 deg. 30. *Mer. Parts* 330,	12.51851
To the *Tangent* of 33 deg. 45 the *Rumb*.	9.82566

Thus if the Places should lie one in the *Latitude* of 50 deg. and the other in the *Latitude* of 55 deg. and the *Difference* of *Longitude* between them were 5 deg. 30 min. the *Rumb* leading from one Place to the other will be found to be the third from the *Meridian* N E by N. 33 deg. 45 min.

Upon the Chart.

THE *Meridians* and *Parallels* being drawn through the two Places at A and C, and a streight Line from A to C, for the *Rumb*, by your *Chord* or *Quadrant* find the quantity of the *Angle* B A C, which you will find to be 33 deg. 45 min. or the third *Lumb* from the *Meridian* N E *by* N.

But if this *Rumb* were to be found by the Common *Sea-Chart*, it would be found to be above 47 deg. that is, N E 2 deg. Easterly; that is, one whole Point and 2 deg. more Easterly than it should be.

V. *The*

V. *The* Latitude *of two Places, and the* Rumb *being given, to find the Difference of* Longitude.

The Analogy or Proportion.

As the *Radius*	10.
Is to the *Tangent* of the *Rumb*, 33 deg. 45 min.	9.82489
So is the *Proper Difference* of *Latitudes*, *Mer. Parts* 493;	2.69285
To 330, the *Difference* of *Longitude* 6 deg. 30 min.	x2.51774

Thus the *Latitude* of one Place being 50 deg. and the other 55 deg. and the *Rumb* leading from one to the other being the third from the *Meridian*, the *Difference* of *Longitude* will be found to be $5\frac{1}{2}$ deg.

Upon the Chart.

LET a *Meridian* be drawn through A, and a Parallel of *Latitude* through C. Then upon the *Angle* A Protract the *Angle* of the *Rumb* 33 deg. 45 min. So the *Distance* B C upon the Parallel, being measured upon the bottom of the *Chart*, will be found to contain 6 deg. 30 min.

But if this *Difference* of *Longitude* were to be found by the *Plain Sea-Chart*, the *Difference* of *Longitude* would be found to be but 3 deg. 20 min. which is more than 3 deg. less than the truth: And yet this Error would be yet greater, if either the *Latitude* be greater, or the *Rumb* farther from the *Meridian*.

VI. *The Difference of* Longitude *of two Places, the* Latitude *of one of them, and the* Rumb *leading from one to the other given, to find the* Latitude *of the other Place.*

The Analogy or Proportion.

As the *Radius*,	10.
To the *Co-Tangent* of the *Rumb*, 56 deg. 15 min.	10.17511
So is the *Difference* of *Longitude* 6 deg. 30 min. (or 330 *Parts*.)	2.51851
To 493, the *Proper Difference* of *Latitude* in *Parts*.	x2.69362

Thus if the *Latitude* of one of the Places were 50 deg. the *Rumb* leading from that to the other N E *by* N. 33 deg. 45 min. and the *Difference* of *Longitude* between the two Places were 5 deg. 30 min. the *Latitude* of the other Place will be found to be in 55 deg.

Upon the Chart.

LEt A B and D C be two *Meridians* drawn through A and C, at $5\frac{1}{2}$ deg. the *Difference* of *Longitude*, and a Parallel of *Latitude* through A, crossing the *Meridian* C D in D: Then upon the Point A Protract an *Angle* equal to the *Rumb* from the *Meridian* given 33 deg. 45 min. So the Line C D, being measured upon the *Meridian* from A, the given *Latitude*, 50 deg. will reach to 55 deg. the proper *Difference* of *Latitude*. So that the other Place lies in the *Latitude* of 55 deg.

But if this *Difference* of *Latitude* were to be found by the *Plain Sea-Chart*, this *Difference* of *Latitude* would be found to be 8 deg. 13 min. and the *Latitude* sought would be found to be 58 deg. 13 min. above 3 deg. more than the truth; as by the *Triangle* for that purpose drawn upon the *Plain Sea-Chart*, marked with T V E may appear.

VII. *Having the* Latitude *of one Place, the* Rumb *leading from that Place to another unknown, and the* Distance *upon the* Rumb *from the first to the second Place, to find the* Difference *of* Longitude *of the two Places.*

The Analogy or Proportion.

As the *Radius*,	10.
Is to the Sine of the *Rumb* from the *Meridian*, 33 deg. 45 min.	9.74474
So is the *Proper Distance* upon the *Rumb* 6 deg. *Parts* 593,	2.77305
To 330 min. (or 5 deg. 30 min.) the *Difference* of *Longitude*.	x2.51779

Thus if the two Places were one in the *Latitude* of 50 deg. and the other in a greater *Latitude*, but unknown; the *Proper Distance* upon the *Rumb* leading from one Place to the other being 6 deg. and the *Rumb* N E by N. 33 deg. 45 min. the *Difference* of *Longitude* will be found to be 5½ deg.

Upon the Chart.

THrough the Point A in the *Latitude* of 50 deg. let be drawn a *Meridian* A B, and a Parallel A D; and upon the Point A Protract an *Angle* equal to the *Rumb* from the *Meridian* 33 deg. 45 min. Then take with the *Compasses* 6 Degrees, the *Proper Distance* upon the *Rumb*, out of the *Meridian-line*, (having respect to the *Latitude* of the Places,) as from K to L, and set that *Distance* upon the *Rumb* from A to C. Then through C draw another *Meridian* C D, crossing the Parallel drawn through A in the Point D. So the Line A D, being measured at the bottom of the *Chart*, will be found to contain 5½ deg. the *Difference* of *Longitude* sought.

But if this *Difference* of *Longitude* had been to be found by the common *Sea-Chart*, it would be found to have been onely 3 deg. 20 min. which is 2 deg. 10 min. less than the truth; as in the *Plain Chart* may be seen, where the Third *Rumb* from the *Meridian* cuts the Parallel of 55 deg. of *Latitude* in 3 deg. 20 min. of *Longitude* at the Point X.

VIII. *The* Difference *of* Longitude *between two* Places, *the* Rumb *leading from one Place to the other, and the* Latitude *of one of the Places being given, to find their* Distance.

The Analogy or Proportion.

As the Sine of the *Rumb* 33 deg. 45 min.	9.74474
Is to the *Radius*,	10.
So is the *Difference* of *Longitude* 5 deg. 30 min. (in Parts 330.)	12.51851
To 6 deg. the proper *Distance* upon the *Rumb*, (or 593.)	2.77377

Thus, if the *Latitude* of one Place were in 50 deg. the other in a greater *Latitude* unknown, the *Difference* of *Longitude* between the two Places 5½ deg. and the *Rumb* N E by N. 33 deg. 45 min. from the *Meridian*; the proper *Distance* upon the *Rumb* will be found to be 6 degrees.

Upon the Chart.

LET two *Meridians*, A B and C D, be drawn through A and C, according to the *Difference* of *Longitude*, and a Parallel of *Latitude* through A, crossing the *Meridian* C D in the Point D. Then upon the Point A Protract an *Angle* of 33 deg. 45 min. the quantity of the *Rumb* from the *Meridian*, and draw the Line A C crossing the *Meridian* C D in C. So the *Distance* C D, being taken in the *Compasses*, and measured upon the *Meridian-line* of the *Chart*, (respect being had to the *Latitude* of Places) that is, so much above the greater *Latitude* as below the lesser *Latitude*, you will find it to contain 6 deg.

But if this setting of the *Compasses* so much above one *Latitude* as below another seem difficult, it may be thus otherwise done.—— For, the *Rumb-line* being drawn, it will cut the *Meridian* C D in C: so a Parallel drawn through C will cut the *Meridian* A B in B: so is B the *Latitude* of the second Place, *viz.* 55 deg. Then divide the *Distance* between the two *Latitudes* A and B in two equal Parts in the Point M; also divide the *Rumb-line* A C in two equal Parts in N: Then take the *Distance* N C or N A, and setting one foot of the *Compasses* in M, the other will reach to L above the greater *Latitude*, and from M to K as much below the lesser *Latitude*, namely, 30 min. or half a Degree on either side; so that between K and L are contained 6 deg. and that is the proper *Distance* upon the *Rumb*.

But if this *Distance* were to be found by the *Plain Chart*, it would be almost 10 deg. or 197 Leagues, which is 77 Leagues more than in truth it should be: As may appear, if you measure the Line A L in the *Plain Chart*, upon the side thereof.

IX. *The Difference of* Longitude, *and Distance of two Places, with the* Latitude *of one of the Places, being given, to find the* Rumb *that leads from one to the other.*

The Analogy or Proportion.

As the proper *Distance* upon the *Rumb* 6 deg. (or 593,)	2.77305
Is to the *Difference* of *Longitude* 5 deg. 30 min. (or 330,)	12.51851
So is *Radius*,	10.
To the Sine of 33 deg. 45 min. the *Rumb* from the *Meridian*.	9.74546

Thus, if one of the Places lay in the *Latitude* of 50 deg. and the other in a greater *Latitude*, but unknown; the *Difference* of *Longitude* between them $5\frac{1}{2}$ deg. and their proper *Distance* upon the *Rumb* 6 deg. the Inclination of the *Rumb* to the *Meridian*, which leadeth from one Place to the other, will be found to be 33 deg. 45 min. that is the N E by N Point.

Upon the Chart.

Let the *Meridians* A B and D C be drawn through A and C, and through A a Parallel of *Latitude* A D: Then open the *Compasses* (having respect to the *Latitudes*) from K to L, the quantity of 6 deg. in the *Meridian*; and setting one foot of that Extent in A, with the other foot cross the *Meridian* C D in C, and draw the Right-Line A C for the *Rumb*. Lastly, By your *Chord* or *Quadrant* find the quantity of the *Angle* B A C, 33 deg. 45 min. and that is the *Rumb* required N E by N.

But if you were to find this *Rumb* by the *Plain Sea-Chart*, it would be found almost the E N E Point within 1 deg. 30 min. differing from truth near 3 whole Points to the Eastward.

X. *The* Longitude *and* Latitude *of two Places being given, to find the Distance upon the* Rumb.

The Analogy or Proportion.

As the proper *Difference* of *Latitude* 493,	2.69285
Is to the *Difference* of *Longitude* 330,	12.51851
So is *Radius*,	10.
To the *Tangent* of 33 deg. 45 min. the *Rumb*.	9.82566
And	
As the Sine of the *Rumb*, 33 deg. 45 min.	9.74474
Is to the *Radius*,	10.
So is the *Difference* of *Longitude* 5 deg. 30 min. (or 330,)	12.51851
To 593, (or 6 deg.) the proper *Distance* upon the *Rumb*.	2.77377

Thus, the two Places being one in the *Latitude* of 50 deg. the other in the *Latitude* of 55 deg. and the *Difference* of *Longitude* between them being $5\frac{1}{2}$ deg. the proper *Distance* upon the *Rumb* will be found to be 6 deg.

Upon the Chart.

Draw the *Meridians* A B and C D, the *Difference* of *Longitude* between them being $5\frac{1}{2}$ deg. and through A and B draw two Parallels B C and A D, and then the Line for the *Rumb* leading from the one to the other A C. So A C, being taken in the *Compasses*, and measured upon the *Meridian-line* of the *Chart*, with this condition, that at the resting of the *Compasses* upon the *Meridian-line*, one foot be so many Degrees above the greater *Latitude* as the other foot is below the lesser *Latitude*; so will the feet of the *Compasses* rest in the Points K and L, one being 30 min. below the lesser *Latitude*, and the other 30 min. above the greater.

But if this *Distance* upon the *Rumb* were to be found by the *Plain Chart*, it would be found to be almost 7 deg. 15 min. or 245 Leagues, which is 25 Leagues more than it should be.

XI. *The*

XI. *The* Latitude *of two Places, and their Distance upon the* Rumb *being given, to find their Difference of* Longitude.

The Analogy or Proportion.

As the proper *Distance* upon the *Rumb* 593,	2.77305
Is to the proper *Difference* of *Latitude* 493,	12.69285
So is *Radius*,	10.
To the Sine of 56 deg. 15 min. the Comp. of the *Rumb*;	9.91980

And

So is the Sine of the *Rumb* from the *Meridian*, 33 deg. 45 min.
To the *Difference* of *Longitude*, 330.

Thus, if one of the Places be in the *Latitude* of 50 deg. and the other in 55 deg. and their proper *Distance* upon the *Rumb* 6 deg. or 120 Leagues; their *Difference* of *Longitude* will be found to be 5 deg. 30.

Upon the Chart.

DRaw A D and B C, two Parallels of *Latitude*, through 50 deg. and 55 deg. which were the two given *Latitudes*: Then out of the *Meridian-line* take the proper *Distance* upon the *Rumb* (having respect to both *Latitudes*) from K to L: the *Compasses* being opened to this *Distance*, one foot being set in A, the lesser *Latitude*, the other will cross the Parallel of the greater *Latitude* in C. So the *Distance* B C, being measured at the bottom of the *Chart* from E, will reach to 5 deg. 30 min. and such is the *Difference* of *Longitude* between the two Places.

But if this *Difference* of *Longitude* were to be found by the *Plain Chart*, it would be but 3 deg. 20 min. which is no less than 2 deg. 10 min. less than the truth; as by the *Triangle* T V E, drawn upon the *Plain Chart*, may appear.

XII. *The Difference of* Longitude *of two Places, their Distance upon the* Rumb, *and the* Latitude *of one of the Places being given, to find the Difference of* Latitudes

The Analogy or Proportion.

As the proper *Distance* of the two Places upon the *Rumb*, 593	2.77305
Is to *Radius*,	10.
So is the *Difference* of *Longitude*, 330,	12.51851
To the Sine of 33 deg. 45 min. the *Rumb*:	9.74546

And

So is the Co-sine of the *Rumb*, 56 deg. 15 min.
To 493, the proper *Difference* of *Latitudes*.

Thus, the *Difference* of *Longitudes* being 5½ deg. their proper *Distance* upon the *Rumb* 6 deg. and the *Latitude* of one of the Places 50 deg. the *Difference* of *Latitudes* will be found to be 5 deg.

Upon the Chart.

THrough the given *Latitude* A draw a *Meridian* A B, and a Parallel A D, and upon the Parallel set the *Difference* of *Longitude* 5½ deg. taken from the bottom of the *Chart*, from A to D, and through D draw the *Meridian* D C: Then out of the *Meridian-line* take the proper *Distance* upon the *Rumb*, 6 deg. from K to L, and setting one foot of the *Compasses* in A, with the other cross the *Meridian* C D in C: so a Parallel of *Latitude* drawn through C will be the Parallel of 55 deg. So is 55 deg. the *Latitude* of the other Place, and 50 being taken from 55, leaves 5 deg. for the *Difference* of *Latitudes* required.

Which *Difference*, had it been to be found by the *Plain Chart*, would have been but 2 deg. 25 min. that is, 2 deg. 35 min. less than the truth; as by the *Triangle* T V E upon the *Plain Chart* may appear.

XIII. *The Latitude of two Places, and their Difference of Longitudes being given, to find the Rumb leading from one to the other, and also how many Degrees distant they are asunder.*

THis Proposition is already performed in the Example of the two Places A and B; but for variety I will take two other Places, and only shew the manner of working upon the Chart.

Suppose then two Places, one (as before) in the Latitude of 50 deg. the other in the Latitude of 52 deg. 30 min. whose Difference of Longitudes is 6 deg.

Upon the Chart.

Through the two given Latitudes, 50 deg. and 52 $\frac{1}{2}$, at A and O draw two Parallels, O P and A D, upon which set the Difference of Longitudes from O to P, and from A to Q, 6 deg. Then draw the Line A P, which shall be the Line of the Rumb leading from one Place to the other: Wherefore, by your Chord or Protracting Quadrant find the Quantity of the Angle O A P, which shall be the Inclination of the Rumb to the Meridian, and will be found to be 56 deg. 15 min. that is, the N E by E Point; which was the first thing that was required.

Then to find the proper Distance upon the Rumb, take the Line A P in your Compasses, and measure it upon the Meridian-line, so that one Foot may be above the greater Latitude so much as the other is below the lesser; and you will find the Compass-points to rest in E and S, E being one whole Degree below the lesser Latitude, and S one Degree above the greater: So that there is intercepted between E and S 4 $\frac{1}{2}$ deg. and that is the proper Distance upon the Rumb, which was the second thing required.

But if this Problem had been wrought upon the Plain Chart, the Rumb from the Meridian would be found to be 67 deg. 23 min. that is, within 7 min. of the sixth Rumb; which is more than the truth by 11 deg. 8 min. almost a whole Point of the Compass.

XIV. *A Ship set sail from the Latitude of 50 deg. upon the Fifth Rumb, N E by E; after that she had made 36 Leagues of Way upon that Rumb, the Wind changing, she was constrained to sail 50 Leagues upon the Seventh Rumb E by N; I would know in what Longitude and Latitude the Ship is.*

Upon the Chart.

THe Rumb-line A P being drawn, set off thereupon 36 Leagues, (which was the Way that the Ship made upon the fifth Rumb before the Wind changed,) from A to T, (which Distance must be taken out of the Meridian-line by opening the Compasses from 50 deg. to 51.48, or better, to as much below 50 deg. as above 51 deg.) so shall the Point T be the Place that the Ship was in when the Wind altered: So a Parallel drawn through T upon the Chart, will cut the Meridian at V in 51 deg. and in that Latitude the Ship was. Now to find in what Longitude she was, take in your Compasses the Line T V, and measure it at the bottom of the Chart, you shall find it will reach from E to 2 deg. 21 min. and in that Longitude the Ship then was.

This done, upon the Point T (where the Wind changed, and drove the Ship two Points more Eastwardly, namely, upon the E by N Point) protract an Angle of 22 deg. 30 min. namely, the Angle P T X, which is the Rumb upon which the Ship sailed 50 Leagues after the Wind changed: Therefore take 50 Leagues out of the Meridian-line, and set them from T to X; so shall X be the Place that the Ship was in after she had sailed 50 Leagues upon the E by N Point; which, by drawing a Parallel through K, will be found in the Latitude of 51 deg. 30 min. and by drawing of a Meridian through K also, it will be found to be in the Longitude of 6 deg. 16 min.

But if these Courses had been protracted according to the Plain Sea-Chart, the Point T would fall in the Latitude of 51 deg. and the Point X in the Latitude of 51 deg. 30 min. But the Longitude of T would be only 1 deg. 30 min. and the Longitude of X is 3 deg. 37 min. Both these Longitudes being added, make but 5 deg.

27 min.

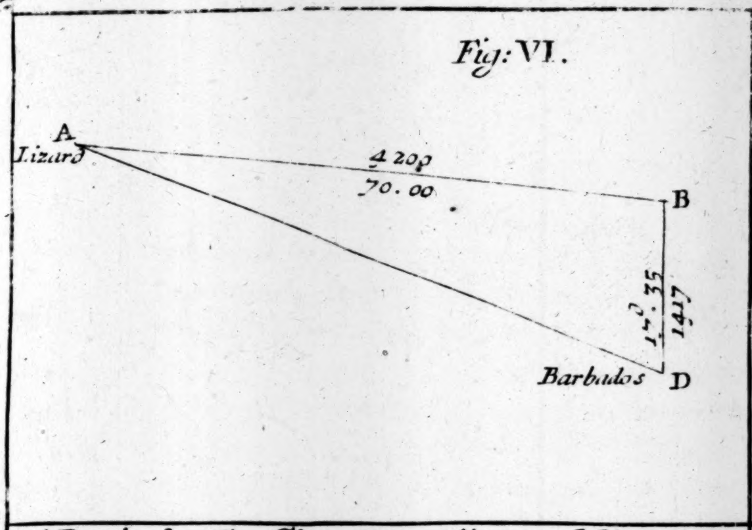


Fig: VI.

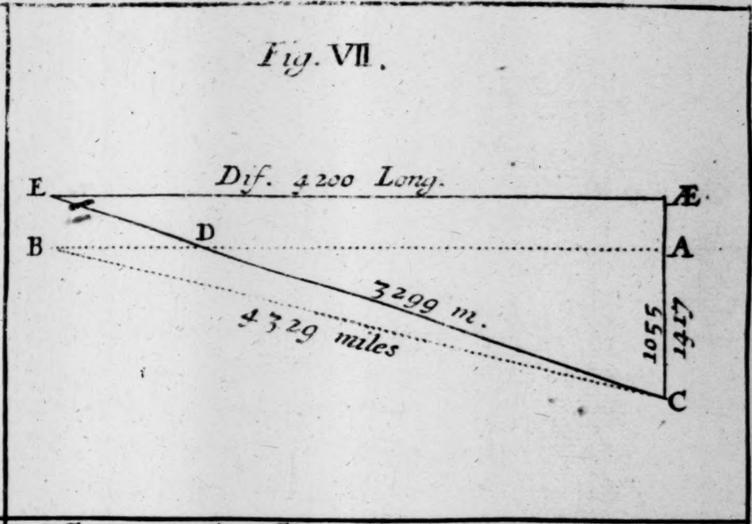


Fig. VII.

A Perticular Sea Chart according to Mercator.

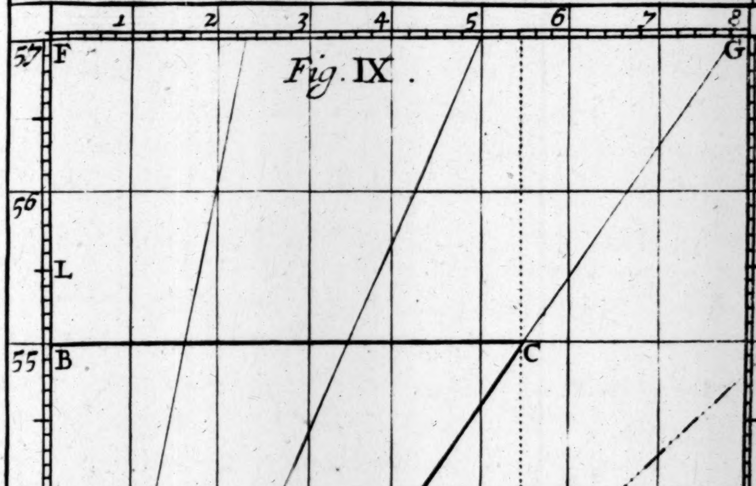


Fig. IX.

A Generall Sea Chart according to Mercator.

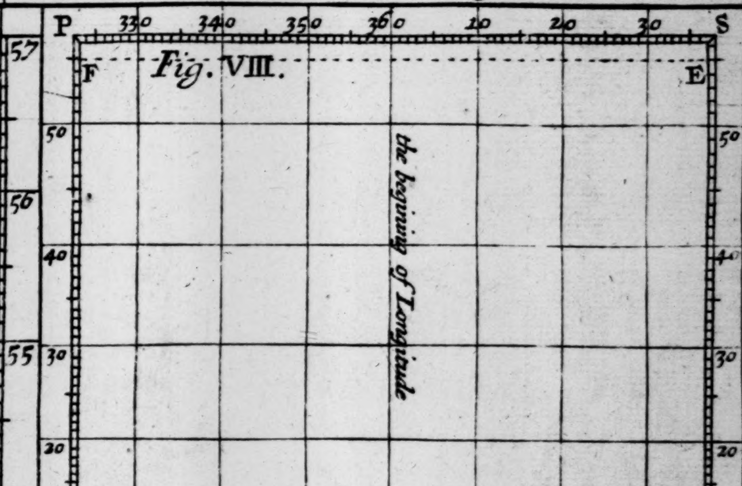


Fig. VIII.

After Page 664, to fold out.

27 min. for the Difference of Longitude between X and the first Meridian; whereas by the other Chart it is 6 deg. 16 min. So that the Ship at X is 33 min. Westward of the Place to which she was bound.

These Differences, which I have observed to be between the Plain and *Mercator*'s Chart, may be seen by comparing the Scheme of the two Charts together.

Concerning a Sea-Voyage, and how to keep a Journal *for that purpose.*

LET the Book in which you keep your Account be in *Folio*, every Right-hand Page being ruled and divided as is done in the Journal following; and let the Left-hand Page against the same be blank, to insert therein the Occurrences which you meet with every day, or at any time, as Occasion offers; as of *Winds*, *Currents*, *Variation* of the *Compass*, *Storms*, and the *Death* of any *Person*, *&c.*

Then write the *Title* of your *Journal*, as from whence you came, in what *Latitude*, whither bound, and in what *Latitude*, *&c.* as you see in the Title of the *Journal* following.

In the *Journal* following there are Eleven Columns, which contain as followeth, *viz.*

The First contains the *Days* of the *Month*.

The Second, the *Month's Name*, and the *Latitude* that *Day*, as it was found by *Observation*.

The Third, the *Course*, as it is corrected by Allowance for *Lee way*, or *Variation* of the *Compass*, if there be any.

The Fourth, the *Distance* sailed.

The Fifth, Sixth, Seventh, and Eighth, the *Easting*, *Westing*, *Northing*, and *Southing*; which are the *Differences* of *Latitude* and *Departure* upon the several *Courses* and *Distances*.

The Ninth is the *Latitude* found by the *Dead Reckoning*.

The Tenth and Eleventh, the *East* or *West Longitude*.

Every one that intends to keeps a true and just Account of the Ship's Way, whensoever demanded, ought (in a Private Book) to take off from the *Log-board*, every day at Noon, (1.) The *Time*. (2.) The *Course* the Ship made her Way upon. (3.) The *Way* the Ship hath made in that time in Knots and parts of a Knot of the *Log-line*. (4.) The *Depths* and *Soundings*. (5.) The *Wind*. And when Opportunity will permit, make Observation of your *Latitude*, and compare the *Observed Latitude* by your *Dead Latitude*, and reconcile them, and then accordingly make your *Entry* in your *Journal*: And the Manner of proceeding in the keeping of this *Journal*, may be as followeth.

THE

Form of the Journal.

A Journal *of our Voyage intended, by God's Assistance, from the* Lizard, *in* 50 *deg. of North Latitude, to the Island of* Barbadoes, *in North Latitude* 13 *deg.* 12 *min. The Difference of Longitude between the* Lizard *and* Barbadoes *is* 52 *deg.* 58 *min. the Course S W ½ W*, March 20. 1684.

Days.	Months and Latitude by Observat.	The Courses Corrected.	Dist. in miles	Northing.	Southing.	Easting.	Westing.	Latitude by Reckoning.	Longitude. East.	Longitude. West.
				Miles.	Miles.	Miles.	Miles.		Miles.	Miles.
	D. M.							*D. M.*		
22	*March.*	*Lizard* South	30		30.0			49 30		
23		South West	112		79.2		79.2	48 11		120.0
24	47 00	S W *by* S ½ W	72		55.6		45.7	47 15		68.1
	Correct by Observation.				15.0		11.0	47 00		16.0
25		S W *by* S	96		79.8		53.3	45 40		75.2
26		S W *by* S	79		65.7		43.9	44 34		62.8
27	42 37	S W *by* S	138		114.6		76.7	42 39		106.2
28		S S W ¼ W	120		110.7		66.3	40 48		88.8
29		S S W	72		66.5		27.6	39 41		36.4
30	37 44	S S W ½ W	102		90.0		48.0	38 11		62.0
	Correct by Observation.				27.0		16.0	37 44		20.0
1	*April.*	South West	85		60.1		60.1	36 44		75.0
2		W S W	20		7.6		18.5	36 36		24.1
3		S *by* W ½ W	32		30.6		9.3	36 05		11.9
4	34 10	S *by* W	120		117.7		23.4	34 07		27.9
	Correct by Observation.			3.00		1.00		34 10	1.00	
5		S *by* W ½ W	164		156.9		47.6	31 33		56.7
6	29 37	S S W	125		115.5		47.9	29 37		55.9
7		S W *by* S	110		91.4		61.2	28 06		69.5
8		S W *by* S	122		101.4		67.8	26 25		76.2
9	24 43	South West	116		82.0		82.0	25 03		91.0
	Correct by Observation.				20.0		11.0	24 43		12.0
10		South West	97		68.6		68.6	23 34		75.0
11		South West	96		67.9		67.0	22 26		74.0
12		South West	114		80.6		80.6	21 05		88.0
13		South West	118		83.5		83.5	19 41		89.0
14		S W *by* W	110		61.2		91.4	18 40		96.2
15		W S W	91		34.8		84.1	18 05		89.4
16		W S W	91		34.8		84.1	17 30		87.0
17		W S W	84		32.1		77.6	16 58		82.0
18		W S W	107		41.0		98.9	16 17		103.7
19		W S W	103		39.5		95.2	15 37		99.0
20	14 43	W S W	116		44.4		107.2	14 53		111.0
	Correct by Observation.				10.0		15.9	14 43		16.0
21		W *by* S	110		21.5		107.9	14 21		114.1
22		W *by* S	120		23.4		117.7	13 58		119.1
23		W *by* S	106		20.7		104.0	13 37		108.7
24		W *by* S	100		19.5		98.1	13 17		103.8
25		W *by* S	120		23.4		117.7	12 54		118.7
26	13 12	W *by* N	100	19.50			98.1	13 14		103.1
27		West	130				130.0	13 12		133.5
28		West	136				136.0	13 12		139.0
29	13 12	West	69				69.0	13 12		70.8
The whole Difference of Longitude is 3178 Miles.									1.00	3176.8

Example.

EXAMPLE.

On the 22d of *March*, at Noon, I find the *Lizard* to bear North, and to be distant 30 miles; therefore I am to the Southward of the *Lizard* 30 Miles, which I place in the South Column of my *Journal*, and that makes my *Latitude* to be 49 deg. 30 min. which I place in the Ninth Column of my *Journal*.

The 23d day the Course is South-West, and the *Distance* sailed 112 Miles: Having these two, you may by the *Difference* of *Latitude* and *Departure*, found by the *Traverse-Table* in *Section* I. before-going, find the Difference of *Latitude* to be 79.2, and the Departure the same; and (because the Course is South-Easterly) I place the Difference of *Latitude* 72.2 in the South Column, and the Departure 79.2 in the West Column, which in Degrees is 1 deg. 19 min. which subtracted from 49 deg. 30 min. (the *Latitude* I was in the day before) there remains 48 deg. 11 min. for the *Latitude* I am now in, which enter in the Ninth Column of the *Journal*. And now to find the Difference of *Longitude*,

In the preceding Column, the Ninth, you have both *Latitudes*, *viz*. 49 deg. 30 m. for the 22d day, and 48 deg. 11 m. for the 23d day, and the Course South-West; by which you may find the Difference of *Longitude*, as hath been shewed before, by this Proportion.

As the *Radius*,
  To the Meridianal Difference of *Latitude*;
So is the *Tangent* of the Course,
  To the Difference of *Longitude*.

Which Difference of *Longitude* will be found to be 120 Miles, which must be placed in the Column of *Longitude*, in the West part thereof, because the Course is Westerly.

The 24th day is to be wrought after the same manner as the 23 day; for having the *Course* and *Distance* given, you may find the *Difference* of *Latitude*, *Departure*, and *Difference* of *Longitude*, as in the day before; which must be entred in your *Journal* in their respective Columns.

How to correct your Dead Reckoning *by Observation of the* Latitude.

On the 24th of *March* by Observation I find the *Latitude* that I am in to be 47 d. whereas by my *Dead Reckoning* I should be in *Latitude* 47 deg. 15 min. so that the Difference is 15 min. Southerly: To correct which, I set 15 min. in the South Column, which subtracted from 47 deg. 15 min. makes my *Latitude* by *Dead Reckoning* to agree with the *Observation*. To correct your *Departure*, you must consider whether the Fault may be imputed to your *Course*, or to your *Distance*. If your *Course* be well steered, and you find no Current, nor any Variation of the Compass, then your Distance is faulty: But if you cannot trust to your Course steered, then the best way is to correct your *Latitude* only, not medling with your Departure. If there be a Current, and you know which way the Current sets, and how fast, then find the Difference of *Latitude*, and Difference of the Current, and add or subtract that *Latitude* and *Departure* to or from the Ship's Difference of *Latitude* and *Departure*, according as the Current doth further or hinder the Ship in her Course. But if by some probable Reason you only conjecture there is a Current, then give what Allowance you think meet in Difference of *Latitude* and Departure, and see if that will reform your Reckoning in your *Latitude*; which if it do, you have well guessed; but if it will not, it is to be supposed that you are mistaken in your Conjecture, or that there is some other Cause of this Error in your Reckoning.

If the Compass vary, (as it often doth) then finding what that Variation is, and which way, you must allow it in the Ship's Course. Now if you cannot impute the Error to any of these, then the *Distance* is faulty; and this is that which usually makes the Difference between the *Observed Latitude* and the *Latitude* by *Dead Reckoning*. And I here take this to be the Cause of the Error this 24th of *March*, and generally in this whole Reckoning.

Now to correct your *Departure* and *Difference* of *Latitude*, you must add up your *East*, *West*, *North*, and *South* Columns, from the day that you correct, to the beginning of your *Journal Table*, if it be the First Correction you have made; or from the day of Correction to the last Correction, if it be the Second; and so between the Second and Third, the Third and Fourth, &c. Then subtract the Summs of the

North and *South* Columns from each other; and likewise the *East* and *West* Columns: And say by Proportion;

As the *Difference* of the *North* and *South* Columns,
Is to the *Difference* of the *East* and *West* Columns,
So is the *Difference* between the *Latitude* by Reckoning, and *Latitude* by Observation,
To the *Difference* in the *Difference*.

And for the *Difference* of *Longitude*; say,

As the *Difference* between the observed *Latitude*, and that by reckoning,
Is to the *Meridianal Difference* of those two *Latitudes*;
So is the *Difference* in the *Departure*,
To the *Difference* in the *Longitude*.

Example in this *Journal*.

This 24th. of *March*, you will find the Summ of the *North* Column to be 00.0. The Summ of the *South* Column (leaving out the 15 min.) to be 164.8; and therefore, their *Difference* is the same 164.8.—— The Summ of the *East* Column is 00.0. The Summ of the *West* Colum is 124.9, and therefore the *Difference* is the same: And then the Operation by the *Logarithms* will be

As the *Difference* of the *North* and *South* Columns 164.8	Co. Ar.	7.78304
To the *Difference* of the *East* and *West* Columns, 124.9		2.09656
So is the *Difference* between the two *Latitudes*, 15 min.		1.17609
To the *Difference* in the *Departure*, 11 Miles.		11.05559

Place this 11 Miles or Minutes in the *West* Column, because the Summ of the *West* Column exceeds that of the *East* Column.

The Tenths of the *Departure* are here neglected.

The Operation for the *Difference* in *Longitude*.

The two *Latitudes* are 47 deg. 15 min. and 47 deg. by which you will find in the *Table* of *Meridional Parts*, the *Meridional Difference* of *Latitude* to be 22 min. Therefore,

As the *Difference* of the two *Latitudes*, 15 min.	Co. Ar.	8.82391
To the *Meridional Difference* of those *Latitudes*, 22		1.34242
So is the *Difference* in the *Departure*, 11		1.04139
To the *Difference* in the *Longitude*, 16		11.20772

This 16 min. is to be placed in the *West* Column, because the *Departure* is *Westward*.

And after the same manner are the Corrections made in this *Journal* on the 30th of *March*, the 4th the 9th and the 20th of *April*; the Errour being supposed to arise from the computation of the *Distance* of the Ships Way.

If your Ship shape several Courses in 24 hours, you are to find your *Difference* of *Latitude* and *Departure* by working a *Traverse*; as hath been taught before: And so, your *Difference* of *Latitude* will give you the *Latitude* that your Ship is in. Then have you two *Latitudes*, namely, the *Latitude* the Ship was in the Day before at Noon, and the *Latitude* it is in at Noon this Day; by which you may find the *Meridianal Difference* of *Latitude* by the *Table* of *Meridianal Parts*, as before hath been taught.

Then for the *Difference* of *Longitude*; say,

As the *Difference* of *Latitude* found by the *Traverse*,
Is to the *Difference* of *Latitude* in *Meridianal Parts*;
So is the *Departure* found by the *Traverse*,
To the *Difference* of *Longitude* for that *Traverse*.

To find the whole *Difference* of *Longitude* of the two Places between which you make your Voyage.

Add up the Columns of *East* and *West Longitude*, and subtract the one from the other, the Remainder is the *Difference* of *Longitude* in Miles.

In this *Journal*, the *Difference* of the *East* and *West* Columns of *Longitude* is 3177.6, or 3178 Miles: which reduced into Degrees and Minutes is 52 deg. 58 min. for the *Difference* of *Longitude* between the *Lizard* and the *Barbadoes*.

The End of the Third Part.

OF NAVIGATION.

PART IV.

OF

Circular-Sailing.

WHEREIN

Divers PROBLEMS of SAILING by the ARCH of a *GREAT CIRCLE* are performed, by *Spherical Projection*, and *Trigonometrical Calculation*.

IN the Two foregoing Ways of *Saling*, the one exceedeth the other: For, as Sailing by *Mercator's Chart* exceedeth that of the *Plain Chart*; so this, by the *Arch* of a *Great Circle*, exceedeth them both. For, forasmuch as the Earth and Sea are a Spherical Body, therefore the most absolute way of Sailing upon the Sea must needs be by the *Arch* of a *Great Circle*, drawn upon the Surface of the Sea, from Place to Place. And here I shall shew, both by *Spherical Projection*, and *Trigonometrical Calculation*, how from any two Places, howsoever situate upon the *Terrestrial Globe*, to find,

I. Their *Nearest Distance* in the *Arch* of a *Great Circle*.
II. The *Angle* of *Position* from one Place to the other.
III. By what *Longitudes* and *Latitudes* the *Arch* so drawn doth pass between the two Places.

SECT. I. *For the* Nearest Distance.

BEfore I come to shew how the *Nearest Distance* between two Places is to be found upon the *Terrestrial Globe*, it will be necessary, first, to describe unto you the Manner how any two Places, whose *Longitudes* and *Latitudes* are given, may be laid down upon the *Projection*. Wherefore in the Scheme, the outward Circle thereof, N Æ S æ, represents the First or General *Meridian*: The Line Æ æ is the *Equinoctial*, upon which the *Longitude* is counted from the *first Meridian*. The Circles N E S, N R S, N C S, and N D S, are Circles of *Longitude*, passing over several Places. The lesser Circles C D F and L B M are Circles or Parallels of *Latitude*. The Points *, *, *, *&c.* are several Places whose Distance we are to find by the following Propositions. And the Points ☉, ☉, ☉, *&c.* are the *Poles* of the *Arches* of *Great Circles*, which pass through the respective Places whose Distance is to be found. Fig. X

And here note, That the *Circles* of *Longitude* in this *Projection* are the same as the *Azimuth Circles* in the former *Meridional Projection*; and the *Centres* and *Poles* of them are found in the same manner. Likewise, the *Parallels* of *Latitude* in this *Projection* are the same with the *Parallels* or *Circles* of *Altitude* in the former *Meridional Projection*, and their *Centres* are found in the same manner as in the Description of that *Projection* prescribed; and therefore it shall here need no more Precepts for its Delineation, but we will proceed to the *Propositions* which shew how to find the Distance of Places.

PROP. I. *Two Places which differ only in* Latitude, *to find their* Distance.

IN this Proposition there are two Varieties.

1. If both the Places lie under one and the same *Meridian*, and on one and the same side of the *Equinoctial*, either on the North or South side thereof, then subtract the lesser *Latitude* from the greater, and the Difference converted into Miles, (by allowing 60 Miles to one Degree) shall give you the Distance.

Example. London and *Ribadio* lie both under one *Meridian*, but they differ in *Latitude*; for *London* hath 51 deg. 30 min. and *Ribadio* hath *Latitude* 43 deg. both North; the Difference of *Latitude* is 8 deg. 30 min. which being turned into Miles, makes 510 Miles.

2. If the two Places lie under one and the same *Meridian*, but one on the North, and the other on the South-side of the *Equinoctial*, add both the *Latitudes* together, the Summ is the Distance.

Example. London and the Island *Tristan Dacunhu* lie both under one *Meridian*; but *London* hath 51 deg. 30 min. North *Latitude*, and the Island hath 34 deg. South *Latitude*; their Summ is 85 deg. 30 min. which converted into Miles, (by dividing the Degrees by 60, and allowing for every Minute one Mile,) makes 5130 Miles: And such is the Distanc of *London* and the Island *Tristan Dacunhu*.

PROP. II. *Two Places which differ only in* Longitude, *to find their* Distance.

IN this Proposition there are two Varieties also. For,

1. The two Places may lie both under the *Equinoctial*, and have no *Latitude*: In this Case the Difference of their *Longitudes* (if it be less than 180 deg.) reduced into Miles, is their Distance; but if their Difference exceed 180 deg. take it out of 360 deg. the remaining Degrees turned into Miles will be the Distance of the two Places.

Example. The Island *Sumatra* and the Island of *S. Thoma* lie both under the *Equinoctial*, the Island of *S. Thoma* having 33 deg. 10 min. of *Longitude*, and the Island *Sumatra* 137 deg. 10 min. The lesser *Longitude* taken from the greater, leaves 104 d. 00 min. which converted into Miles, is 6240; and that is the Distance of the two Islands.

2. But if the two Places differ only in *Longitude*, and lie not under the *Equinoctial* but under some other intermediate *Parallel* of *Latitude*, between the *Equinoctial* and one of the *Poles*; then,

Let the two Places lie both in the *Latitude* of 50 deg. and let their Difference of *Longitude* be 135 deg.

I. By *Projection*.

Having drawn the first *Meridian Circle* N Æ S *æ*, and set the *Common Latitude* upon it, 50 deg. from Æ to C; and from *æ* to F, count 135 deg. upon the *Equinoctial* from Æ to E, and draw the *Meridian* N E S, passing through the other Place at D, in the same *Parallel* of *Latitude*, 50 deg.

Then through the Points C and D describe an *Arch* of a *Great Circle* C D G, passing through the two Places C and D, the *Pole* of which *Circle* is at A. Now to find the Distance between C and D in the *Arch* of the *Great Circle*, lay a Ruler to A and D, it will cut the first *Meridian* in *a*; so the Distance C *a* measured upon the *Scale* of *Chords*, will be 72 deg. 52 min. which converted into Miles, is 4372 Miles, for the Distance of the two Places.

II. By *Trigonometry*.

By the Intersection of the three *Great Circles* in the *Projection*, you have constituted the *Oblique-angled Spherical Triangle* C N D, in which is given,

(1.) The two Sides N C and N D, the *Complements* of the *Common Latitude*, 40 d.
(2) The *Angle* C N D, the *Difference* of *Longitude*, 135.deg.

By which you may find the Side C D,

By *Case* VI. of *Oblique-angled Spherical Triangles*;

Or rather the Half of it, by the following *Analogy*.

As

As the *Radius*, 90 deg.	10.
To the Co-sine of the Common Latitude, C N or N D, 40 deg.	9.80806
So is the Sine of Half the Difference of Longitude, 67 deg. 30 min.	9.96561
To the Sine of Half the Distance, 36 deg. 26 min.	x9.77367

Which doubled is 72 deg. 52 min. and that multiplied by 60, produceth 4372 Miles, as before; and that divided by 3, gives 1457 Leagues and one Mile, for the Distance in the *Arch* of a *Great Circle*.

PROP. III. *Two Places differing both in* Longitude *and* Latitude, *to find their* Distance.

There are three Varieties contained in this Proposition. For,

1. One of the Places may lie under the *Equinoctial*, and have no Latitude; and the other under some Parallel of Latitude, between the *Equinoctial* and one of the *Poles*.

I. By *Projection*.

Thus, suppose the two Places to be, one at H, lying under the *Equinoctial*, and the other at C, under the Parallel of 50 deg. and differing in Longitude 158 deg.

The two Places upon the Projection are represented by C and H, the Point H lying under the *Equinoctial*, and the Point C under the Parallel of 30 deg. North, and differing in Longitude 158 deg. Through the two Places C and H (according to former Directions) draw an *Arch* of a *Great Circle*, C H G, and find the *Pole* thereof, which will be at the Point A. Then, a Ruler laid to A, and the Point H, will cut the first *Meridian* in *n*; the Distance *n* C being measured upon the Line of *Chords*, will be found to contain 126 deg. 23 min. which in Miles is 7583, or in Leagues 2527 and 2 Miles.

II. By *Trigonometry*.

By the Intersection of the three *Great Circles* in the Projection, there is constituted, the *Quadrantal Spherical Triangle* C N H, or rather its Opposite H S G, whose Side H S is a Quadrant, in which there is given, besides the Quadrant's Side H S,

(1.) The *Angle* H S G, 22 deg. the Complement of the Difference of Longitude to 180 deg.

(2.) The Side S G, equal to Æ C, the Latitude 50 deg. By which you may find the Side H G,

By the XVI. *Case* of *Right-angled Spherical Triangles*.

As the *Radius*, 90 deg.	10.
Is to the *Co-sine* of H S G, 68 deg. the Difference of Longitude	9.96716
So is the *Sine* of S G, the *Co-Latitude* 40 deg.	9.80807
To the *Sine* of 36 deg. 35 min.	9.77523

Whose Complement 53 deg. 25 min. is the Side H G, and that subtracted from 180 deg. leaves 126 deg. 23 min. for the Side C D H, which is the Distance between the two Places, and will be found as before to be 7583 Miles.

2. If both the Places proposed shall be without the *Equinoctial*, but on one Side thereof, either both towards the North, or both towards the South.

So the two Places propounded lying both in North Latitude, one in 50 deg. and the other in 15 deg. and differing in Longitude 60 deg. you may find their Distance as followeth.

I. By *Projection*.

The two Places in the Projection are represented by the Letters C and B, through which Points draw the *Arch* of a *Great Circle* C B G, and find its *Pole* at K. Wherefore lay a Ruler from K to B, it will cut the first *Meridian* in *g*; and the Distance *g* C measured upon the Scale of *Chords*, will be found to contain 59 deg. 25 min. and that is their Distance, which in Miles is 3565.

II. By *Trigonometry*.

By the Intersection of the three *Great Circles* in the Projection, there is constituted the *Oblique Spherical Triangle* N C B, in which is given,

(1.) The

(1.) The Side C N (40 deg.) the Complement of the Latitude of the Place at C.
(2.) The Side N B (75 deg.) the Complement of the Latitude of the Place at B.
(3.) The Angle C N B (60 deg.) the Difference of Longitude between the two Places.

By which may be found the third Side B C,

By *Case* VI. of *Oblique-angled Spherical Triangles*,

(1.) As the *Radius*, 90 deg.	10.
To the *Co-sine* of C N B, 30 deg. the Difference of Longitude	9.69897
So is the *Tangent* of C N, 40 deg.	9.92381
To a fourth *Tangent*, 22 deg. 46 min.	x9.62278

Subtract this fourth *Tangent*, 22 deg. 46 min. from the Side B N 75 deg. the Remainder will be 52 deg. 14 min. for the Segments of the Base (or Side) N O and O B. Then say,

(2.) As the *Co-sine* N O, 22 deg. 46 min.	Co. Ar. 0.03523
To the *Co-sine* O B, 52 deg. 14 min.	9.78707
So is the *Co-sine* N C, 40 deg.	9.88425
To the *Co-sine* C B, 30 deg. 35 min.	x9.70655

Whose Complement 59 deg. 25 min. is the Side C B; and that converted into Miles, makes 3565 for the Distance of the two Places in the *Arch* of a *Great Circle*.

3. The two Places may be so situate, that one of them may lie on the North, the other on the South-side of the *Equinoctial*: And to find their Distance,

I. By *Projection*.

The two Places in the Projection are represented by the Letters L and P, L being in 15 deg. of North Latitude, and P in 62 deg. 30 min. of South Latitude. The *Meridian* passing through L is the *Primitive Circle*; the *Meridian* passing through P is N B P S; and the *Great Circle* passing through both the Places is L P; and the *Pole* thereof R. Now to find the Distance, lay a Ruler from R to P, it will cut the first *Meridian* in *k*; the Distance between L and *k* measured upon the Scale of *Chords*, will be found to contain 89 deg. 38 min. for the Distance of the two Places L and P, which make in Miles 5378.

II. By *Trigonometry*.

In the Projection, by the Intersections of the three *Great Circles*, is constituted the *Oblique-angled Spherical Triangle* L P S, in which is given,
(1.) The Side P S, 27 deg. 30 min. (the Complement of the greater Latitude.)
(2.) The Side L S, 105 deg. (the lesser Latitude) with 90 deg. added thereto.
(3.) The Angle P S L, 60 deg. (the Difference of Longitude between the two Places.

By which you may find the Side L P the Distance.

By *Case* VI. of *Oblique-angled Spherical Triangles*.

(1.) As the *Radius*, 90 deg.	10.
To the *Co-sine* of Difference of Longitude, P S L	9.69897
So is the *Co-tangent* of the greater Latitude P S, 27 deg. 30 min.	9.71647
To the *Tangent* of 14 deg. 36 min.	x9.41544

	deg.	min.
From the Side L S	105	00
Subtract the Fourth Arch	14	36
The Remainder is	90	24

Then say,

(2.) As the *Co-sine* of the Fourth Arch	Co. Ar. 0.01425
Is to the *Co-sine* of the lesser Latitude, 15 deg.	9.94793
So is the *Co-sine* of the *Arch* remain. 90 deg. 24 min.	7.84092
To the *Co-sine* of the Distance, 89 deg. 38 min.	x7.80310

Which turned into Miles, is 5378, as before.

These are all the Varieties of Positions of Places upon the *Terrestrial Globe*: for no two Places (whose Distance can be required) but they must fall under one or other

of

of the Varieties contained in some of these three Propositions. And note that this way of finding the *Distance* of Places is the most absolute and exact of any other. — And what is here said concerning finding these *Distances* I shall apply to *Circular Sailing*, of all other ways the most perfect.

SECT. II. *For the Angle of* Direct Position *from one Place to another.*

AS the *Distance* of Places were measured by the Sides, so the *Positions* of Places are measured by the *Angles* of *Spherical Triangles*: And in the resolving of some *Problems* of this nature, I shall retain the same method as in finding of *Distances*, *viz.* First by the *Projection*, and then by *Trigonometry*. *Fig.* XI.

PROB. I. *Two Places, one lying under the* Equinoctial, *the other in any* Latitude, *and the Difference of* Longitude *between them being given to find the direct Position of the First Place from the Second, and of the Second from the First.*

I. By *Projection.*

Having drawn a Primitive *Meridian*, as the Circle A B Q G P, let one Place be D, under the *Equinoctial*; the other A, in 50 deg. of *North Latitude*: and let the *Difference* of *Longitude* between them be 51 Degrees, as B D. The *Triangle* thus projected, the things required to be found are, (1.) The *Angle* B A D. And (2.) The *Angle* A D B.

1. For the *Angle* B A D, a Ruler laid from A to C will cut the *Primitive Circle* in *a*, and the *Distance a* E, measured upon the *Scale* of *Chords*, will be found to contain 58 deg. 11 min. for the *Angle* of *direct Position* from the Place at A, to the Place at C.

2. For the *Angle* A D B; a Ruler laid from A to C will cut the *Meridian* in *a*, (as before,) and a Ruler laid from H (the *Pole* of the *Circle* A C F) to *a*, will cut the *Circle* A C F in *b*: Then a Ruler laid from D to *b*, will cut the *Meridian* in *c*: The *Distance c* G, measured, will be found to be 56 deg. 53 min. for the *Angle* G D F; to which A D B is equal, and is the *Angle* of *direct Position* between D and A.

II. By *Trigonometry.*

By the Intersection of the *Equinoctial*, and the great Circle A D F, with the *Meridian*, is constituted the *Triangle* A B D, Right-angled at B; in which is given,

(1.) The side A B, the *Latitude*. 50 deg.
(2.) The side B D 51 deg. the *Difference* of *Longitude* of the two Places; by which you may find the *Angle* B A D.

By *Case* XV. of Right-angled Spherical *Triangles*.

As the *Radius*, 90 deg.	10.
Is to the *Sine* of A B 50 deg.	9.88425
So is the *Co-Tangent* of B D. 51 deg.	9.90837
To the *Tangent* of 30 deg. 49 min.	19.79262

Whose Complement 58 deg. 11 min. is the *Angle* B A D.

Then for the *Angle* A B D, by the VI. *Case*.

As the *Radius*, 90 deg.	10.
To the *Co-Sine* of A B, 50 deg.	9.80806
So is the *Sine* of D A B, 58 deg. 11 min.	6.92928
To the *Sine* of 33 deg. 7 min.	19.73734

Whose Complement 56 deg. 53 min. is the quantity of the *Angle* of *Position* A D B.

II. *Two*

II. *Two Places Differing in* Latitude, *and their Difference of* Longitude *being given, to find the* Angle *of* direct Position *from the First to the Second, and from the Second to the First.*

Let the two Places be the *Lizard*, lying in the *Latitude* of 50 deg. and the other the *Summer Islands*, lying in 32 deg. 25 min. of *North Latitude*, and their *Difference* of *Longitude* 70 deg. the several Positions of these Places one from the other is required.

I. By *Projection*.

Set the *Latitude* of the *Lizard* 50 deg. from G to L, (P being the *North Pole:*) also set the *Difference* of *Longitude* 70 deg. from G to T, and draw the *Meridian* P T Q, and from T to S set the *Latitude* of the *Summer Islands* 32 deg. 25 min. then through L and S, draw the great *Circle* M S L, passing through both Places, and by their Intersections is made the Oblique angled *Triangle* P S L; in which,

P L is the Complement of the *Latitude* of the *Lizard*, 40 deg.

P S the Complement of the *Latitude* of the *Summer Islands*, 57 deg. 35 min.

S L the nearest *Distance* between the two Places in the Arch of a great *Circle*; which may be found by the directions of the last *Section* to be 53 deg. 24 min.

Now the things we are to seek are, (1.) The *direct Position* from *Summer Islands* to the *Lizard*, P S L. And (2.) The *direct Position* from the *Lizard* to the *Summer Islands*, P L S.

1. For the *Angle* P S L.

A Ruler laid from N, the *Pole* of the *Meridian* P T Q, to S, will cut the *Primitive Circle* in *d*; and 90 deg. set upon the same *Circle* from *d*, will reach to *c*; a Ruler laid from N to *c* will cut the *Meridian* of the *Summer Islands* P T Q in *e*.

Also, a Ruler laid from K (the *Pole* of the great *Circle*, which passeth through both the Places, (*viz.* L S M) to S, will cut the *Primitive Circle* in *f*, and 90 deg. set from *f*, will reach to *g*; a Ruler laid from K to *g* will cut the great *Circle* M S L in *b*.

Lastly, A Ruler laid from S to *e* and *b*, will cut the *Primitive Circle* in *k* and *l*: and the *Distance* *k l* measured upon the *Scale* of *Chords*, will be found to contain 48 deg. 47 min. for the *Angle* M S Q, to which P S L is equal, and is the *direct Position* from the *Summer Islands* to the *Lizard*.

2. For the *Angle* P L S.

A Ruler laid from L to *o*, will cut the *Primitive Circle* in *q*, the *Distance* from *q* to V, measured upon the *Scale* of *Chords*, will be found to be 81 deg. 8 min. which is the *Angle* of the *direct Position* from the *Lizard* toward the *Summer Islands*.

II. By *Trigonometry*.

By the Intersections of the two great *Circles* passing through both the Places, with the general *Meridian*, there is constituted the *Oblique-angled Spherical Triangle* P S L; in which is given,

(1.) The side P S 57 deg. 35 min. the Complement of the *Latitude* of the *Summer Islands*.

(2.) The side P L 70 deg. the *Difference* of *Longitude* between the Places.

(3.) The side P L, 40 deg. the Complement of the *Latitude* of the *Lizard*: whereby you may find the *Angles* at S and L.

I. For the *Angle* P S L.

By *Case* V. of *Oblique-angled Sherical Triangles*.

(1.) As the *Radius*, 90 deg.	10.
To the *Co-sine* P, 70 deg.	9.53405
So is *Tangent* P L 40 deg.	9.92381
To a Fourth *Tangent*, *viz.* 16 deg. 1 min.	~~1~~9.45786

	deg.	min.
From P S	57	35
Subtract	16	01
There Remains	41	34

(2.) As

(2.) As the *Sine* of 16 deg. 1 min. Co. Ar. 0.55966
Is to the *Sine* of the Remainder 41 deg. 34 min. 9.82183
So is the *Co-Tangent* P, 70 deg. 9.56106
To the *Tangent* of 41 deg. 13 min. x9.94255

Whose Complement, 48 deg. 47 min. is the quantity of the *Angle* P S L, and is the *Angle* of *direct Position* from *Summer Islands* to the *Lizard*.

II. For the *Angle* P L S, having attained the *Angle* P S L, say,
By *Case* I. of *Oblique-angled Spherical Triangles*,

As the *Sine* of P L, 40 deg. Co. Ar. 0.19193
Is to the *Sine* of PS L, 48 deg. 47 min. 9.87634
So is the *Sine* of P S, 57 deg. 35 min. 9.92643
To the *Sine* of P L S 81 deg. 5 min. x9.99470

Which is the *Angle* of *direct Position* from the *Lizard* to the *Summer Islands*.

SECT. III. *Of finding by what* Longitudes *and* Latitudes *the Arch of any great Circle, (drawn as before,) shall pass between any two Places.*

Having in the two foregoing *Sections* shewed how to find the *Distance* of any two Places, howsoever situate in the Arch of a great Circle; as also, to find the *Angles* of direct *Position* from one to the other: The work of this Third *Section* shall be to find by what *Longitudes* and *Latitudes* the Arch of such a great Circle doth pass; both by *Projection* and *Trigonometrical Calculation*: And our first *Example* shall be between the same two Places as were mentioned in the Second *Problem* of the Second *Section* foregoing; *viz.* the *Lizard* and the *Summer Islands*.

For the performance of the Work of this Third *Section*, it will be necessary to have a perfect Projection of the whole *Sphere* or *Globe*, with all its *Meridians* and *Parallels*; the Projection whereof, (with some Uses of the same) is taught where we treat of Spherical Projection, but for our present occasion I have here again added another *Scheme* of the same Projection; referring the Reader for its Construction to the fore-cited Place; and shall here immediately proceed to the Use of the same Projection in *Navigation*.

PROB. I. *The* Latitudes *of two Places, and their Difference of* Longitude *being given, to find by what* Longitudes *and* Latitudes, *the great Circle leading to those Places doth pass.*

I. By *Projection*.

Let the two Places be the *Summer Islands*, lying in the *Latitude* of 32 deg. 25 min. and the *Lizard*, lying in the *Latitude* of 50 deg. both *North*, and differ in *Longitude* 70 deg.

1. Count upon your Projection the *Latitude* of one of the Places, as *Summer Islands*, 32 deg. 25 min. in the outermost Circle at S: [And herein regard must be had to the Bearing of the two Places: For if the Second Place lie *West* from the First, then set down the First Place on the *East* (or right) side of the Projection: But if the Second Place lie *Eastward* of the First, (as in this *Example*,) then you must set down the First Place on the *West* side of the Projection, as it is here at S.]

2. From the Point S, through the Centre E, draw the Diametre S E K, and cross it at Right-Angles, with the Line M E N.

3. The *Difference* of *Longitude* being 70 deg. count 70 deg. upon the *Equinoctial*, from C to 70, and upon that *Meridian*, count 50 deg. the *Latitude* of the *Lizard*, and there set L. And thus have you your two Places set down according to their true *Latitudes* and *Difference* of *Longitude* in the Projection.

4. Through the two Places S and L, you must draw the Arch of the great *Circle* S L K, as is taught in the 63*d*. *Geometrical Problem*, and also in *Spherical Projection*, several times.

5. The

5. The great Circle being drawn, you may find the *Pole* thereof at ⊙. The Projection thus prepared, if you would know,

1. By what *Longitudes* and *Latitudes* the Arch of the great Circle passeth: This may be done by inspection; for if you trace with your Eye, or with a Needle's Point, you shall see that the 10*th Meridian* from S, crosseth the great Circle at 38 deg. 51 min. of *Latitude*, at 20 deg. *Difference* of *Longitude*, it crosseth the great Circle at 43 deg. 34 min. of *Latitude*; and so of the rest, as in this *Table*.

At		D.		M.
00	Degrees Diff. of Longit.	32	Degrees of Latitude	25
10		38		51
20		43		34
30		46		54
40		49		04
50		50		15
60		50		33
70		50		00

2. The *Angle* of *Position* from S to L. To find this, take in your *Compasses* the *Distance* from T, (the Point where the great Circle crosseth the Diametre thereof M N) to N, that *Distance* measured upon the *Equinoctial* from C, will reach to about 49 deg. and that is the *Angle* of *Position North-easterly*.

3. The *Distance* between S and L. Lay a Ruler from ⊙, the *Pole* of the great Circle, to S, and note where it cuts the outermost *Meridian*, and from that Point take the *Distance* to S; that *Distance* measured upon the Primitive *Meridian* from C, shall give you the *Distance* 53 deg. 24 min.—— And in this manner you may measure any Part of the Arch of the great Circle, as between every 10*th* or 5*th Meridian*, or *Difference* of *Longitude*.

And in this manner may any two Places, howsoever situate in respect of *Longitude* or *Latitude*, be set upon the Projection; an Arch of a great Circle passing through them be drawn: their *Distance* measured: the *Angle* of their *Position* found: And by what *Longitudes* and *Latitudes* the Arch of the great Circle passeth. As by two or three *Examples* which follow will plainly appear.

II. By *Trigonometry*.

For the better Illustration of the *Trigonometrical Operations* following I have here inserted a particular Part of the former *Sphere*, it being an *Oblique-angled Spherical Triangle*, comprehending all such Parts of the several *Meridians*, as lie between the two Places, (or every 10*th* of them.)

In which *Triangle*,

Fig. XIII. P represents the *North-Pole*.
S *Summer Islands*.
L the *Lizard*.

And in it there is given,

S P, the Complement of the *Latitude* of *Summer Islands*,	57 deg. 35 min.
P L, the Complement of the *Latitude* of the *Lizard*,	40 deg. 00 min.
S P L, the *Difference* of *Longitude*,	70 deg. 00 min.

These things known, it is required to find the *Longitudes* and *Latitudes* by which this Arch S L doth pass.

In this *Case* it will be requisite to let fall a Perpendicular from the *Pole* P to the Arch of the great Circle S L; which let be P B.

And then let it be required to find,

(1.) The Perpendicular it self.

(2.) The Parts of the Vertical *Angle*, *viz.* the *Angles* S P B, and L P B.

And these being known, all the others will be *Right-angled Triangles*, and so be resolved at One operation.

I. For the *Perpendicular* P B,

There is given, (1.) The *Hypotenuse* S P, the Complement of the *Latitude* of *Summer Islands*, 57 deg. 35 min. (2.) The *Angle* of *Position* at S, (as before it was found to be) 48 deg. 47 min. To find P B.

By the IV. *Case* of *Right-angled Spherical Triangles*.

As the *Radius*, 90 deg.	10.
To the *Sine* of P S, 57 deg. 35 min.	9.92643
So is the *Sine* of the *Angle* P S B, 48 deg. 47 min.	9.87635
To the *Sine* of the Perpendicular P B, 39 deg. 25 min.	19.80278

Whose Complement 50 deg. 35 min. is the greatest *Latitude* by which the great Circle S B L doth pass.

II. For

Fig. X.

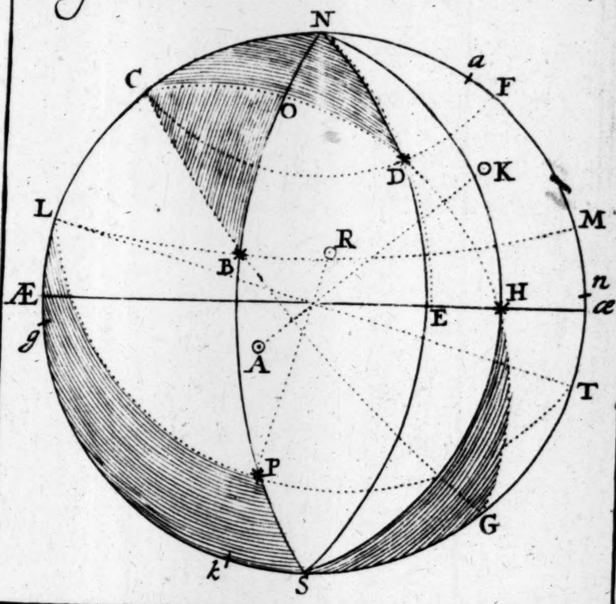


Fig. XIII.

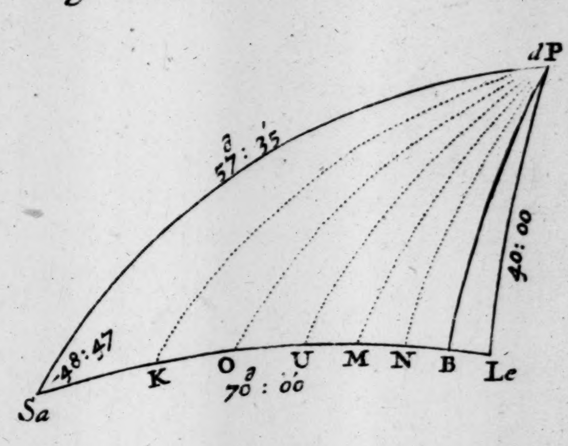


Fig. XI.

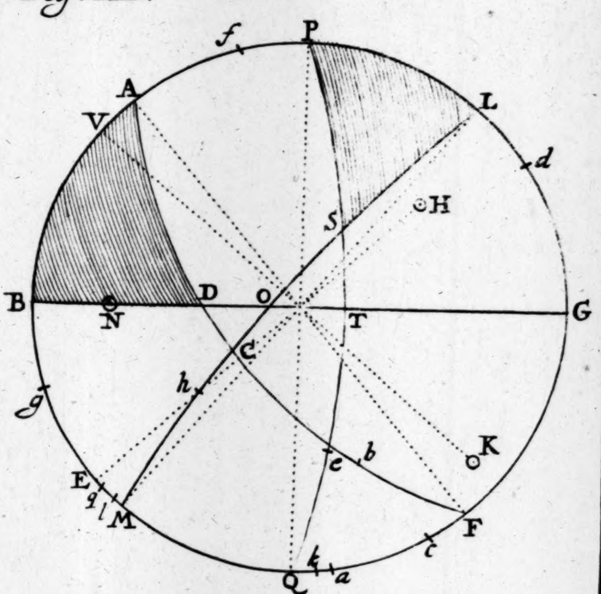
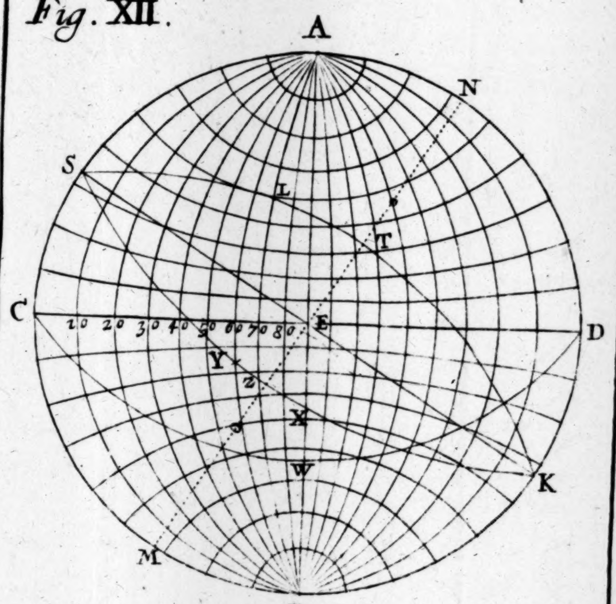


Fig. XII.



After Page 671, to fold out.

II. For the *Angles* S P B and L P B,

By the III. *Case* of *Right-angled Spherical Triangles*,

As the *Radius*, 90 deg.	10.
To the *Co-sine* of P S, 32 deg. 25 min.	9.72922
So is the *Tangent* of P S L, 48 deg. 47 min.	10.05752
To the *Tangent* of S P B, 31 deg. 29 min.	x9.78674

Whose Complement 58 deg. 31 min. is the Angle S P B.

And being the whole Angle S P L is 70 deg. 58 deg. 31 min. being taken therefrom, there remains 11 deg. 29 min. for the Angle B P L.

So that for the greatest *Latitude* of this *Great Circle*, which is B, we have found the *Difference* of *Longitude* from L to L P B, 11 deg. 29 min. and from the Angle S P B, 58 deg. 31 min.

Now the *Difference* of *Longitude* from S to L being 70 deg. let it be required to find by what *Latitudes* the *Arch* S L doth pass, for every Tenth Degree of *Difference* of *Longitude* from S.

Suppose the Point K to differ in *Longitude* from S 10 deg. and I would know the *Latitude* of the same Point K.

Seeing we have before found the Angle S P B to be 58 deg. 31 min. and the Angle S P K being (by Supposition) 10 deg. therefore the Angle K P B is 48 deg. 31 min. And the Perpendicular P B we found before to be 39 d. 26 min. by which may be found the Complement of the *Latitude* P K,

By *Case* VII. of *Right-angled Spherical Triangles*,

As the *Radius*, 90 deg.	10.
Is to the *Co-sine* of K P B, 48 deg. 31 min.	9.82112
So is the *Co-tangent* of P B, 39 deg. 26 min.	10.08492
To the *Tangent* of 38 deg. 51 min.	x9.90604

Whose Complement is 51 deg. 9 min. the *Latitude* at K.

In like manner, supposing,

The Point		to differ in *Longitude* from S	deg.	we shall find the *Latitude* of the Point		to be in the *Latitude* of	deg.	m.
	O		20		O		43	44
	V		30		V		46	54
	M		40		M		49	04
	N		50		N		50	15

And thus much for finding what *Longitudes* and *Latitudes* the *Arch* of a *Great Circle* between any two Places do pass, by *Trigonometrical Calculation*.

But before I leave this Way of *Great Circle Sailing*, I will add two *Problems* more, necessary therein, to be performed upon the *Projection*; and those are, First, To find the *Distance*, *Angle of Position*, and the *Longitudes* and *Latitudes* by which the *Great Circle* shall pass in several Positions, one Place being in the *Equinoctial*, and the other either in North or South *Latitude*: The other, one in North, and one in South *Latitude*.

II. *Two Places, one lying under the* Equinoctial Circle, *and the other in* South Latitude, *to find their* Distance, *their* Angle of Position, *and by what* Longitudes *and* Latitudes *the same* Great Circle *must pass*.

Let one Place be St. *Thomas* Island, lying under the *Equinoctial*, and so hath no *Latitude*; let the other be the *Streights of Magelan*, lying in 53 deg. of South *Latitude*, and differing in *Longitude* from St. *Thomas* 90 deg. Westward.

I. *To place the two Places upon the* Projection, *and to describe the* Great Circle.

First, Set down the Island of St. *Thomas* at one end of the *Equinoctial* at D; then accounting thereon 90 deg. of *Longitude* from D to E, there is the *Meridian* of the *Streights of Magelan*; whereupon you must mark out the *Latitude* thereof, which is 53 deg. Southward, at the Point W: And thus have you three Points, D, W, and C, through which the *Arch* of the *Great Circle* must be described, as hath been taught before. Now this part of the *Great Circle* which lies between D and W, is the *Arch* of the *Great Circle*; by which may be found all the other things required: As,

II. *To find the* Longitudes *and* Latitudes *by which this* Great Circle *passeth.*

This is done by carrying your Eye along, or tracing with a Needle's Point the *Arch* it ſelf, obſerving where it croſſeth the *Meridians* and *Parallels* of *Latitude* in the *Projection*, which you ſhall find for every Tenth Degree to be as is exhibited in this Table.

Degrees of Longitude.	Degrees of Latitude. Deg.	Min.
10	12	58
20	24	25
30	33	34
40	40	28
50	45	31
60	43	58
70	51	16
80	52	35
90	53	00

III. *To find the* Angle *of* Poſition *between the two Places.*

This is ſhewed by the *Arch* D W croſſing the *Semidiametre* E B: So that if you take the *Distance* B W, and meaſure it in the *Equinoctial* C D, it will reach from C to 37 deg. which is the *Angle* of *Poſition* required, and ſhews it to be South-weſterly.

IV. *For the* Diſtance *of the two Places.*

If you take the Diſtance D W, and meaſure it upon the 37 *Meridian Circle*, (which anſwers to the *Angle* of *Poſition*,) it will reach from A (the *Pole*) to C, in the *Equinoctial* upon the 37th *Meridian*; which ſhews the *Diſtance* to be 90 deg.

III. *Two Places, one lying on the North, the other on the South-ſide of the* Equinoctial, *to find their* Diſtance, *the* Angle of Poſition, *and the* Longitudes *and* Latitudes *by which the* Arch *of the* Great Circle *paſſeth.*

Let the two Places be the *Summer Iſlands*, in 32 deg. 25 min. of North *Latitude*; and the other, the *Cape of Good Hope*, in 35 deg. of South *Latitude*; and their Difference in *Longitude* 90 deg.

I. *To place the two Places upon the* Projection, *and to draw the* Great Circle.

Count the *Latitude* of the firſt Place, *Summer Iſlands*, 32 deg. 25 min. from C to S, upon the *Primitive Circle*, and draw the Diametre S K, croſſing it at Right-Angles with another Diametre, N M: Then count the Difference of *Longitude*, 90 deg. upon the *Equinoctial* from C, and the *Meridian* of the *Cape of Good Hope* will fall to be the Diametre A B, upon which from E you muſt count the *Latitude* of the *Cape*, 35 deg. downwards towards B, at X; and by the Points S, X, and K, deſcribe the *Great Circle Arch* S X K, as hath been often taught before.

II. *To find the* Longitudes *and* Latitudes *by which the* Great Circle *paſſeth.*

Trace with a Needle (or only caſt an Eye along the *Great Circle Arch*) obſerving where the *Arch* croſſeth the *Meridians* and *Parallels* of *Latitude* upon the *Projection*, which for every Tenth Degree of *Longitude* will be as in this Table.

Degrees of Longitude.	Degrees of Latitude. Deg.	Min.
0	32	25
10	26	57
20	19	40
30	11	18
40	2	5
50	7	19
60	16	7
70	23	48
80	30	5
90	35	00

III. *To find the* Angle of Poſition *between the two Places.*

Obſerve where the *Arch* S X K doth croſs the Line N M, which is at Z; then with your Compaſſes take the Diſtance Z M, and meaſure it in the *Equinoctial*, and you ſhall find it to reach from C to about 60 deg. *viz.* to 59 deg. 25 min. South-Eaſterly, which is the *Angle of Poſition.*

IV. *For the* Diſtance *of the two Places.*

If you take the *Diſtance* of the two Places in the *Arch* S X, and meaſure it in the *Meridian* of 60, (the Meaſure of the *Angle of Poſition*,) you ſhall find it to reach from A to Y, which is 107 deg. 34 min. and that is the Diſtance of the two Places.

The End of the Fourth Part.

Here followeth a Connex of ſuch TABLES, *and the Uſes of them, as are of continual Uſe in* Navigation.

KALENDARIUM NAUTICUM:

A

DIARY

OF THE

SUN, MOON, and FIXED STARS,

Fitted for the Daily Use of

MARINERS.

A TABLE *of the Moveable Feasts, from the Year* 1688, *to the Year* 1713. *In the* Julian *and* Gregorian *Accounts.*

The *Julian* Account.							*Gregorian* Account.				
Years of Christ.	*Prime or Gold.Num.*	*Epact.*	*Domin. Letter*	*Shrove-Sunday.*	*Easter-Day.*	*Whit-Sunday.*	*Prime.*	*Epact.*	*Domin. Letter.*	*Easter-Day.*	*Whit-Sunday.*
1688	17	7	A G	*Febr.* 26	*April* 15	*June* 3	17	27	D C	*March* 18	*June* 6
1689	18	18	F	10	*March* 31	*May* 19	18	8	B	*April* 10	*May* 29
1690	19	29	E	*March* 2	*April* 20	*June* 8	19	19	A	*March* 26	14
1691	1	11	D	*Febr.* 22	12	*May* 21	1	1	G	*April* 19	*June* 7
1692	2	12	C B	7	*March* 27	15	2	12	F E	6	*May* 25
1693	3	3	A	27	*April* 17	*June* 5	3	23	D	*March* 22	10
1994	4	14	G	18	8	*May* 27	4	4	C	*April* 11	30
1695	5	25	F	*March* 3	*March* 24	12	5	15	B	3	22
1696	6	6	E D	*Febr.* 23	*April* 12	31	6	26	A G	22	*June* 10
1697	7	17	C	14	4	23	7	7	F	7	*May* 26
1698	8	28	B	*March* 6	*April* 24	*June* 12	8	18	E	*March* 23	11
1699	9	9	A	*Febr.* 19	9	*May* 28	9	29	D	*April* 19	*June* 7
1700	10	20	G F	11	*March* 31	19	10	10	C B	10	*May* 29
1701	11	1	E	*March* 2	*April* 20	25	11	21	A	13	*June* 11
1702	12	12	D	*Febr.* 15	5	24	12	2	G	15	3
1703	13	23	C	7	*March* 28	16	13	13	F	7	*May* 26
1704	14	4	B A	27	*April* 16	*June* 5	14	24	E D	*March* 22	10
1705	15	15	G	18	8	*May* 17	15	5	C	*April* 11	30
1706	16	26	F	3	*March* 24	12	16	16	B	3	22
1707	17	7	E	23	*April* 13	*June* 1	17	27	A	23	*June* 11
1708	18	18	D C	15	4	*May* 23	18	8	G F	7	*May* 26
1709	19	29	B	*March* 6	24	*June* 12	19	19	E	*March* 23	11
1710	1	11	A	*Febr.* 19	9	*May* 28	1	1	D	*April* 19	*June* 7
1711	2	22	G	11	1	21	2	12	C	4	*May* 23
1712	3	3	F E	24	14	*June* 2	3	23	B A	23	*June* 11

The SOLAR KALENDAR.

JANUARY.

Tables of the Sun's Declination, *with their* Differences, *for the Years of our Lord.* — *Tables of the* Sun's Right Ascension.

South Declination Decreasing.

Month Days.	Week Days.	Fixed Feasts, and The Sun's Place.	Leap-y. 1680 1684 1688 1692 1696 D.	M.	Difference. M.	I. After. 1681 1685 1689 1693 1697 D.	M.	Difference. M.	II. Aft. 1682 1686 1690 1694 1698 D.	M.	Difference. M.	III. Aft. 1683 1687 1691 1695 1699 D.	M.	Difference. M.	Month Days.	The *Sun's Right Ascension,* Time. H.	M.	Compl. H.	M.
1	a	*Circumcis.*	21	50	10	21	43	10	21	45	10	21	47	9	1	7	35	4	25
2	b	22 ♑ 56	21	40	10	21	33	11	21	35	10	21	38	10	2	7	38	4	21
3	c	23 57	21	30	10	21	22	11	21	25	11	21	28	11	3	7	43	4	17
4	d	24 59	21	20	11	21	11	11	21	14	11	21	17	11	4	7	47	4	13
5	e	26 0	21	9	12	21	00	12	21	3	12	21	6	12	5	7	51	4	9
6	f	*Epiphany.*	20	57	12	20	48	12	20	51	12	20	54	12	6	7	56	4	4
7	g	28 2	20	45	12	20	36	12	20	39	12	20	42	12	7	8	0	4	0
8	a	29 3	20	33	12	20	24	13	20	27	13	20	30	13	8	8	5	3	56
9	b	0 ♒ 4	20	21	13	20	11	13	20	14	13	20	17	13	9	8	9	3	51
10	c	1 6	20	9	13	19	58	14	20	1	14	20	4	13	10	8	13	3	47
11	d	2 7	19	55	14	19	44	14	19	49	14	19	51	14	11	8	17	3	43
12	e	3 8	19	41	14	19	30	14	19	35	14	19	37	14	12	8	21	3	48
13	f	*Hilary.*	19	27	15	19	16	15	19	19	14	19	23	15	13	8	25	3	34
14	g	5 10	19	12	15	19	1	15	19	4	15	19	8	14	14	8	30	3	30
15	a	6 11	18	57	15	18	46	15	18	50	14	18	54	15	15	8	34	3	26
16	b	7 12	18	42	15	18	31	16	18	35	15	18	39	16	16	8	38	3	22
17	c	8 13	18	27	16	18	15	16	18	19	16	18	23	16	17	8	42	3	18
18	d	9 14	18	11	16	17	59	17	18	3	16	18	7	16	18	8	46	3	14
19	e	10 15	17	55	17	17	42	16	17	47	16	17	51	17	19	8	50	3	10
20	f	11 16	17	38	16	17	26	17	17	30	17	17	34	17	20	8	54	3	6
21	g	*Agnes.*	17	22	17	17	9	18	17	13	17	17	17	17	21	8	59	3	2
22	a	*Vincent.*	17	5	18	16	51	17	16	56	17	17	0	18	22	9	3	2	57
23	b	14 19	16	47	17	16	34	18	16	38	18	16	41	17	23	9	7	2	53
24	c	15 19	16	30	18	16	16	18	16	20	18	16	25	18	24	9	10	2	50
25	d	*Conv.Paul.*	16	12	18	15	58	18	16	2	18	16	7	18	25	9	15	2	45
26	e	17 21	15	54	19	15	40	19	15	44	18	15	49	19	26	9	19	2	41
27	f	18 22	15	35	19	15	21	19	15	25	19	15	30	19	27	9	23	2	37
28	g	19 23	15	16	19	15	2	19	15	7	18	15	11	19	28	9	27	2	33
29	a	20 23	14	57	19	14	43	11	14	48	19	14	52	19	29	9	31	2	29
30	b	21 24	14	38	20	14	22	18	14	28	20	14	33	20	30	9	35	2	25
31	c	22 25	14	18		14	4		14	8		14	13		31	9	38	2	22

The LUNAR KALENDAR.

Years of Christ.	☌ ☉ ☾ New Moon. D.	H.	M.		□ ☉ ☾ First Quart. D.	H.	M.		☍ ☉ ☾ Full Moon. D.	H.	M.		□ ☉ ☾ Last Quarter D.	H.	M.	
1688	22	10	12	Nig.	29	1	0	Aft.	7	1	12	Aft.	15	4	50	Aft.
1689	11	10	10	Mor.	18	8	26	Mor.	25	10	14	Mor.	3	1	2	Aft.
1690	30	8	17	Mor.	8	4	53	Mor.	15	3	38	Mor.	22	6	8	Mor.
1691	19	10	8	Mor.	27	7	10	Mor.	4	11	40	Mor.	11	6	55	Mor.
1692	8	9	52	Mor.	16	12	46	Noo.	23	2	30	Aft.	30	5	34	Mor.
1693	26	5	38	Mor.	4	12	1	Noo.	12	4	0	Mor.	18	9	55	Nig.
1694	15	1	14	Aft.	23	7	39	Mor.	31	3	34	Mor.	8	7	52	Nig.
1695	5	3	5	Mor.	12	3	0	Mor.	20	5	41	Mor.	28	1	23	Mor.
1696	24	5	36	Mor.	30	11	55	Nig.	9	6	36	Mor.	17	10	0	Mor.
1697	12	9	0	Nig.	19	12	10	Noo.	27	1	53	Mor.	5	10	28	Mor.
1698	2	8	48	Mor.	9	9	21	Mor.	16	7	7	Mor.	24	3	26	Mor.
1699	21	4	0	Mor.	28	2	25	Aft.	5	7	0	Nig.	12	12	10	Nig.

The SOLAR KALENDAR.

FEBRUARY.

Tables of the Sun's Declination, *with their* Differences, *for the Years of our Lord.*

Month Days.	Week Days.	Fixed Feasts, and The Sun's Place.	Leap-y. 1680 1684 1688 1692 1696 D.	M.	Difference. M.	I. After. 1681 1685 1689 1693 1697 D.	M.	Difference. M	II. Aft. 1682 1686 1690 1694 1698 D.	M.	Difference. M.	III. Aft. 1683 1687 1691 1695 1699 D.	M.	Difference. M.
1	d	23 ♒ 25	13	56	20	13	44	20	13	48	20	13	53	20
2	e	*Purif. Mar.*	13	39	20	13	23	21	13	28	20	13	33	20
3	f	25 27	13	10	22	13	3	20	13	8	20	13	13	21
4	g	26 27	12	58	20	12	43	21	12	48	21	12	52	20
5	a	27 28	12	38	21	12	22	21	12	27	21	12	32	21
6	b	28 28	12	17	21	12	1	21	12	6	21	12	11	21
7	c	29 29	11	56	21	11	40	21	11	45	21	11	50	21
8	d	0 ♓ 29	11	35	21	11	19	22	11	24	22	11	29	21
9	e	1 30	11	14	22	10	57	21	11	2	22	11	8	21
10	f	2 30	10	52	22	10	36	22	10	40	21	10	47	23
11	g	3 30	10	30	22	10	14	22	10	19	22	10	24	22
12	a	4 31	10	8	22	9	52	22	9	57	22	10	2	22
13	b	5 31	9	46	22	9	30	23	9	35	22	9	40	22
14	c	*Valent.*	9	24	22	9	7	22	9	18	23	9	18	23
15	d	7 32	9	2	22	8	45	23	8	50	23	8	55	22
16	e	8 32	8	39	23	8	22	22	8	27	22	8	33	22
17	f	9 32	8	17	23	8	0	23	8	5	23	8	11	23
18	g	10 32	7	54	23	7	37	23	7	42	22	7	44	22
19	a	11 32	7	31	23	7	14	23	7	20	23	7	26	23
20	b	12 32	7	8	23	6	51	24	6	57	23	7	3	24
21	c	13 32	6	45	23	6	28	24	6	34	24	6	39	23
22	d	14 32	6	22	23	6	4	23	6	10	23	6	16	23
23	e	15 32	5	59	23	5	41	22	5	47	23	5	53	23
24	f	S. *Matth.*	5	36	24	5	18	23	5	24	24	5	30	25
25	g	17 32	5	12	23	4	55	24	5	0	23	5	5	22
26	a	18 32	4	49	23	4	31	23	4	37	24	4	43	24
27	b	19 32	4	25	23	4	8	24	4	13	23	4	19	23
28	c	20 32	4	2		3	44		3	50		3	56	
29			3	39										

South Declination Decreasing.

Tables of the Sun's Right Ascension.

Month Days.	The *Sun's Right Ascension.* Time. H.	M.	Compl. H.	M.
1	9	42	2	18
2	9	46	2	14
3	9	50	2	10
4	9	54	2	6
5	9	58	2	2
6	10	2	1	58
7	10	6	1	54
8	10	10	1	50
9	10	14	1	46
10	10	17	1	43
11	10	21	1	39
12	10	25	1	35
13	10	29	1	31
14	10	33	1	27
15	10	36	1	24
16	10	40	1	20
17	10	44	1	16
18	10	48	1	12
19	10	52	1	8
20	10	55	1	5
21	10	59	1	1
22	11	5	0	55
23	11	8	0	52
24	11	12	0	48
25	11	15	0	45
26	11	19	0	41
27	11	23	0	37
28	11	26	0	34
29				

The LUNAR KALENDAR.

Years of Christ.	☌ ☉ ☾ New Moon. D.	H.	M.		□ ☉ ☾ First Quart. D.	H.	M.		☍ ☉ ☾ Full Moon. D.	H.	M.		□ ☉ ☾ Last Quart. D.	H.	M.	
1688	21	8	24	Mor.	27	12	36	Nig.	6	7	4	Mor.	14	10	30	Mor.
1689	9	11	21	Nig.	16	3	41	Aft.	24	2	12	Mor.	1	11	56	Nig.
1690	28	11	4	Nig.	6	1	49	Aft.	13	8	39	Mor.	21	2	24	Mor.
1691	18	4	28	Mor.	25	5	39	Aft.	2	9	51	Nig.	9	12	9	Nig.
1692	7	4	31	Mor.	15	6	26	Mor.	21	11	48	Nig.	28	7	37	Nig.
1693	24	10	50	Nig.	3	7	53	Mor.	10	3	52	Aft.	17	8	30	Mor.
1694	14	2	50	Mor.	22	1	51	Mor.	No Full Moon.				7	3	7	Mor.
1695	3	1	52	Aft.	10	9	40	Nig.	18	12	13	Nig.	26	8	1	Mor.
1696	21	3	20	Aft.	28	3	43	Aft.	8	2	16	Mor.	15	12	21	Nig.
1697	11	9	34	Mor.	17	10	36	Nig.	25	8	10	Nig.	4	5	43	Mor.
1698	1	1	26	Aft.	7	4	22	Aft.	14	10	2	Nig.	22	11	33	Nig.
1699	19	7	52	Nig.	26	9	42	Nig.	4	2	49	Mor.	11	8	0	Nig.

The SOLAR KALENDAR.
MARCH.

Tables of the Sun's Declination, with their Differences, for the Years of our Lord. | Tables of the Sun's Right Ascension.

Month Days.	Week Days.	Fixed Feasts, and The Sun's Place.	Leap-y. 1680 1684 1688 1692 1696 D.	M.	Difference. M.	I. After. 1681 1685 1689 1693 1697 D.	M.	Difference. M.		II. Aft. 1682 1686 1690 1694 1698 D.	M.	Difference. M.	III. Aft. 1683 1687 1691 1695 1699 D.	M.	Difference. M.	Month Days.	The Sun's Right Ascension, Time. H.	M.	Compl. H.	M.
1	d	David B.	3	15	24	3	20	23	South Decl. decreasing. *	3	26	23	3	32	23	1	11	29	0	31
2	e	22 ♓ 31	2	51	23	2	57	24		3	3	24	3	9	24	2	11	33	0	27
3	f	23 31	2	28	24	2	33	24		2	29	23	3	45	24	3	11	35	0	25
4	g	24 31	2	4	24	2	9	23		2	16	24	2	21	23	4	11	40	0	20
5	a	25 31	1	40	24	1	46	24		2	22	24	2	58	24	5	11	43	0	17
6	b	26 30	1	16	23	1	22	23		1	28	23	1	34	23	6	11	46	0	14
7	c	27 29	0	53	24	0	59	24		1	5	24	1	11	24	7	11	50	0	10
8	d	28 29	0	29	24	0	35	24		0	41	24	0	46	23	8	11	53	0	7
9	e	29 28	0	5	24	0	11	24		0	17	11	0	23	22	9	11	57	0	3
10	f	0 ♈ 28	0 *	18	24	0 *	13	23		0 *	6	24	0 *	1	24	10	0	1	11	59
11	g	1 27	0	42	23	0	37	24		0	30	24	0	25	24	11	0	5	11	55
12	a	2 27	1	6	24	0	0	23		0	54	24	0	49	23	12	0	8	11	52
13	b	3 26	1	29	23	1	24	24	North Declination Increasing.	1	18	24	1	12	24	13	0	12	11	48
14	c	4 25	1	53	24	1	47	24		1	42	23	1	36	23	14	0	15	11	45
15	d	5 25	2	16	24	2	11	23		2	5	24	2	0	23	15	0	19	11	41
16	e	6 24	2	40	23	2	35	23		2	29	23	2	23	23	16	0	23	11	37
17	f	7 23	3	4	23	2	58	24		2	52	23	2	46	24	17	0	26	11	34
18	g	Edward.	3	27	24	3	21	23		3	15	24	3	10	23	18	0	30	11	30
19	a	9 21	3	50	23	3	45	23		3	36	23	3	33	23	19	0	33	11	27
20	b	10 20	4	14	23	4	8	23		4	2	23	3	56	23	20	0	37	11	23
21	c	11 19	4	37	21	4	31	23		4	25	24	4	19	24	21	0	41	11	19
22	d	12 18	5	0	23	4	54	23		4	49	23	4	43	23	22	0	44	11	16
23	e	13 17	5	23	23	5	17	23		5	12	23	5	6	23	23	0	48	11	12
24	f	14 16	5	46	23	5	40	23		5	35	22	5	29	23	24	0	51	11	9
25	g	Annun. M.	6	9	22	6	3	22		5	57	23	5	52	23	25	0	55	11	5
26	a	16 14	6	31	23	6	25	23		6	20	22	6	15	22	26	0	59	11	1
27	b	17 13	6	54	22	6	48	23		6	42	23	6	37	23	27	1	3	10	57
28	c	18 12	7	16	22	7	11	22		7	5	23	7	0	22	28	1	6	10	54
29	d	19 11	7	38	22	7	33	22		7	28	22	7	22	23	29	1	10	10	50
30	e	20 9	8	1	22	7	55	22		7	50	22	7	45	22	30	1	14	10	46
31	f	21 8	8	23		8	17			8	12		8	7		31	1	17	10	43

The LUNAR KALENDAR.

Years of Christ.	☌ ☉ ☽ New Moon. D.	H.	M.	□ ☉ ☽ First Quart. D.	H.	M.	☍ ☉ ☽ Full Moon. D.	H.	M.	□ ☉ ☽ Last Quarter D.	H.	M.
1688	21	5	15 Aft.	28	2	29 Aft.	7	2	0 Mor.	15	1	14 Mor.
1689	11	10	0 Nig.	17	12	17 Nig.	25	6	4 Nig.	4	5	8 Mor.
1690	30	10	8 Mor.	7	8	6 Nig.	14	10	14 Nig.	22	9	46 Nig.
1691	19	7	52 Nig.	27	1	30 Mor.	4	8	25 Mor.	11	6	30 Nig.
1692	7	10	30 Nig.	15	1	42 Aft.	22	8	53 Mor.	29	11	36 Mor.
1693	26	4	0 Aft.	5	2	17 Mor.	12	1	30 Mor.	18	5	19 Nig.
1694	15	5	41 Aft.	23	7	52 Nig.	1 31	4 2	13 N. 3 M.	8	9	40 Mor.
1695	5	1	21 Mor.	12	5	3 Aft.	20	2	50 Aft.	27	1	46 Aft.
1696	23	1	0 Mor.	30	9	22 Mor.	8	7	51 Nig.	16	10	55 Mor.
1697	12	5	14 Aft.	19	11	24 Mor.	27	1	23 Aft.	5	10	20 Nig.
1698	1 31	10 4	34 N. 15 M	8	12	4 Nig.	16	4	18 Aft.	24	5	20 Nig.
1699	21	8	54 Mor.	28	3	30 Mor.	5	7	14 Nig.	12	3	45 Aft.

The SOLAR KALENDAR.
APRIL.

Month Days.	Week Days.	Fixed Feasts, and The Sun's Place.		Tables of the Sun's Declination, with their Differences, for the Years of our Lord. Leap-y. 1680 1684 1688 1692 1696 D.	M.	Difference. M.	I. After. 1681 1685 1689 1693 1697 D.	M.	Difference. M		II. Aft. 1682 1686 1690 1694 1698 D.	M.	Difference. M.	III. Aft. 1683 1687 1691 1695 1699 D.	M.	Difference. M.	Tables of the Sun's Right Ascension. Month Days.	The Sun's Right Ascension. Time. H.	M.	Compl. H.	M.
1	g	22 ♈	7	8	45	22	8	39	22	North Declination Increasing.	8	3[illegible]	22	8	29	22	1	1	21	10	39
2	a	23	5	9	7	22	9	1	22		8	56	22	8	51	22	2	1	25	10	35
3	b	24	4	9	29	21	9	23	21		9	18	21	9	13	21	3	1	29	10	31
4	c	25	2	9	50	21	9	44	22		9	39	22	9	34	22	4	1	33	10	27
5	d	26	1	10	11	21	10	6	21		10	1	21	9	56	21	5	1	36	10	24
6	e	26	59	10	32	21	10	27	21		10	22	21	10	17	21	6	1	40	10	20
7	f	27	58	10	53	21	10	48	21		10	44	21	10	38	21	7	1	44	10	16
8	g	28	56	11	14	21	11	9	20		11	3	21	10	59	21	8	1	47	10	13
9	a	29	55	11	35	20	11	30	20		11	25	21	11	20	20	9	1	51	10	9
10	b	0 ♉	53	11	55	20	11	50	20		11	46	20	11	40	21	10	1	54	10	6
11	c	1	51	12	15	20	12	10	20		12	6	20	12	1	20	11	1	58	10	2
12	d	2	50	12	35	20	12	30	20		12	26	20	12	21	20	12	2	2	9	58
13	e	3	48	12	55	20	12	50	20		12	46	20	12	41	20	13	2	6	9	54
14	f	4	46	13	15	19	13	10	19		13	6	19	13	1	19	14	2	10	9	50
15	g	5	44	13	34	19	13	29	19		13	25	19	13	20	20	15	2	13	9	47
16	a	6	42	13	53	19	13	48	19		13	44	19	13	40	19	16	2	17	9	43
17	b	7	40	14	12	19	14	7	19		14	3	19	13	59	19	17	2	21	9	39
18	c	8	39	14	31	19	14	26	18		14	22	19	14	18	18	18	2	25	9	35
19	d	9	37	14	50	18	14	45	18		14	41	18	14	36	19	19	2	29	9	31
20	e	10	35	15	08	18	15	3	18		14	59	18	14	55	18	20	2	32	9	28
21	f	11	33	15	26	17	15	21	17		15	17	18	15	13	18	21	2	36	9	24
22	g	12	31	15	44	17	15	39	18		15	35	18	15	31	17	22	2	40	9	20
23	a	S. George.		16	1	17	15	56	17		15	53	17	15	48	18	23	2	44	9	16
24	b	14	26	16	18	17	16	14	16		16	10	17	16	6	17	24	2	48	9	12
25	c	*Mar. Eva.*		16	35	17	16	31	18		16	27	17	16	23	17	25	2	51	9	9
26	d	16	22	16	52	16	16	47	16		16	44	17	16	40	17	26	2	55	9	5
27	e	17	20	17	9	16	17	5	16		17	1	16	16	57	16	27	2	59	9	1
28	f	18	18	17	25	15	17	21	16		17	17	16	17	13	16	28	3	3	8	57
29	g	19	16	17	41	15	17	37	15		17	43	16	17	29	15	29	3	7	8	53
30	a	20	13	17	56		17	52			17	59		17	44		30	3	10	8	50

The LUNAR KALENDAR.

Years of Christ.	☌ ☉ ☾ New Moon. D.	H.	M.		□ ☉ ☾ First Quart. D.	H.	M.		☍ ☉ ☾ Full Moon. D.	H.	M.		□ ☉ ☾ Last Quart. D.	H.	M.	
1688	20	3	27	Mor.	27	6	14	Mor.	5	6	4	Nig.	13	12	0	Noo.
1689	9	6	32	Nig.	16	10	42	Mor.	24	11	0	Mor.	2	9	31	Nig.
1690	28	7	0	Nig.	6	2	2	Mor.	14	9	34	Mor.	21	3	7	Aft.
1691	18	9	40	Mor.	25	7	4	Mor.	2	7	22	Nig.	10	1	5	Aft.
1692	6	3	6	Aft.	14	3	33	Mor.	20	5	49	Aft.	28	4	6	Mor.
1693	25	8	20	Mor.	3	4	52	Aft.	10	9	44	Mor.	17	6	0	Mor.
1694	14	9	6	Mor.	22	12	5	Noo.	29	10	13	Mor.	6	4	50	Aft.
1695	3	1	41	Aft.	11	11	46	Nig.	19	2	0	Mor.	25	7	11	Nig.
1696	21	11	0	Mor.	29	2	41	Mor.	7	11	10	Mor.	14	5	42	Aft.
1697	11	1	32	Mor.	18	1	52	Mor.	26	5	27	Mor.	4	11	0	Mor.
1698	30	2	14	Mor.	7	10	8	Mor.	15	6	19	Mor.	23	7	55	Mor.
1699	19	6	46	Nig.	25	1	4	Aft.	4	8	50	Mor.	12	9	44	Mor.

The SOLAR KALENDAR.
MAY.

Tables of the Sun's Declination, *with their* Differences, *for the Years of our Lord.* — *Tables of the* Sun's Right Ascension.

North Declination Increasing.

Month Days.	Week Days.	Fixed Feasts, and The Sun's Place.		Leap-y. 1680 1684 1688 1692 1696 D.	M.	Difference. M.	I. After. 1681 1685 1689 1693 1697 D.	M.	Difference. M.	II. Aft. 1682 1686 1690 1694 1698 D.	M.	Difference. M.	III. Aft. 1683 1687 1691 1695 1699 D.	M.	Difference. M.	Month Days.	The *Sun's Right Ascension,* Time. H.	M.	Compl. H.	M.
1	b	*Phil. & Ja.*		18	11	15	18	8	15	18	4	15	18	0	15	1	3	14	8	46
2	c	22 ♉	9	18	26	15	18	23	14	18	19	15	18	15	15	2	3	18	8	42
3	d	23	6	18	41	14	18	37	15	18	34	14	18	30	15	3	3	22	8	38
4	e	24	4	18	55	14	18	52	14	18	48	14	18	45	14	4	3	26	8	34
5	f	25	2	19	9	14	19	6	13	19	2	14	18	59	14	5	3	30	8	30
6	g	25	59	19	25	14	19	19	14	19	16	14	19	13	14	6	3	34	8	26
7	a	26	57	19	36	13	19	33	13	19	30	13	19	27	13	7	3	38	8	22
8	b	27	54	19	49	13	19	46	13	19	43	12	19	40	13	8	3	52	8	18
9	c	28	52	20	2	12	19	59	12	19	56	12	19	53	12	9	3	56	8	14
10	d	29	49	20	14	12	20	11	13	20	8	12	20	5	13	10	3	50	8	10
11	e	0 ♊	47	20	26	12	20	24	12	20	20	12	20	18	12	11	3	54	8	6
12	f	1	44	20	38	11	20	36	11	20	32	11	20	30	11	12	3	58	8	2
13	g	2	41	20	49	11	20	47	10	20	43	12	20	41	11	13	4	2	7	58
14	a	3	39	21	0	10	20	57	11	20	55	11	20	52	11	14	4	6	7	54
15	b	4	37	21	11	10	21	9	10	21	6	10	21	3	11	15	4	10	7	50
16	c	5	34	21	21	10	21	19	10	21	16	10	21	14	10	16	4	14	7	46
17	d	6	31	21	31	9	21	29	9	21	26	10	21	24	10	17	4	18	7	42
18	e	7	29	21	40	10	21	38	9	21	36	9	21	34	9	18	4	22	7	38
19	f	8	26	21	50	9	21	47	9	21	45	9	21	43	9	19	4	26	7	34
20	g	9	23	21	59	8	21	56	9	21	54	8	21	52	9	20	4	30	7	30
21	a	10	21	22	7	8	22	5	8	22	2	9	22	1	8	21	4	34	7	26
22	b	11	18	22	15	7	22	13	8	22	11	8	22	9	8	22	4	38	7	22
23	c	12	15	22	22	7	22	21	7	22	19	9	22	17	7	23	4	42	7	18
24	d	13	12	22	29	7	22	28	7	22	24	9	22	24	7	24	4	46	7	14
25	e	14	10	22	36	6	22	35	6	22	33	7	22	31	7	25	4	50	7	10
26	f	15	7	22	43	6	22	41	6	22	40	6	22	48	6	26	4	54	7	6
27	g	16	4	22	49	5	22	47	6	22	46	6	22	44	6	27	4	58	7	2
28	a	17	1	22	55	5	22	53	5	22	52	5	22	50	6	28	5	2	6	58
29	b	17	58	23	0	4	22	58	5	22	57	5	22	56	5	29	5	6	6	54
30	c	18	56	23	5	4	23	3	5	23	2	5	23	1	5	30	5	11	6	49
31	d	19	53	23	9		23	8		23	7		23	6		31	5	15	6	45

The LUNAR KALENDAR.

Years of Christ.	☌ ☉ ☾ New Moon. D.	H.	M.	□ ☉ ☾ First Quart. D.	H.	M.	☍ ☉ ☾ Full Moon. D.	H.	M.	□ ☉ ☾ Last Quarter D.	H.	M.
1688	19	4	10 Mor.	26	10	41 Nig.	5	9	36 Mor.	12	6	56 Nig.
1689	9	1	34 Mor.	15	11	21 Nig.	24	2	10 Mor.	{ 2 31	10 7	26 M. 40 N. }
1690	28	2	31 Aft.	5	9	0 Mor.	13	3	19 Mor.	21	5	53 Mor.
1691	17	6	29 Nig.	26	9	50 Mor.	{ 2 31	8 7	12 M. 54 N. }	10	5	37 Mor.
1692	6	4	48 Mor.	12	10	48 Nig.	20	3	40 Mor.	27	9	9 Nig.
1693	24	11	7 Nig.	{ 2 31	5 3	47 Af. 6 Af. }	9	5	37 Nig.	16	8	0 Nig.
1694	13	12	41 Nig.	22	1	11 Mor.	28	5	56 Nig.	6	2	2 Mor.
1695	3	3	0 Mor.	11	4	54 Mor.	18	11	8 Mor.	24	12	53 Mor.
1696	20	9	52 Nig.	28	8	12 Nig.	6	11	45 Nig.	13	10	33 Nig.
1697	10	9	39 Mor.	17	5	37 Nig.	25	7	13 Nig.	3	7	46 Nig.
1698	29	9	10 Mor.	6	8	24 Nig.	14	9	55 Nig.	22	7	11 Nig.
1699	19	2	43 Mor.	25	5	7 Nig.	3	11	13 Nig.	12	2	10 Mor.

The SOLAR KALENDAR.
JUNE.

Tables of the Sun's Declination, with their Differences, for the Years of our Lord.

Month Days.	Week Days.	Fixed Feasts, and The Sun's Place.	Leap-y. 1680 1684 1688 1692 1696 D.	M.	Difference. M.	I. After. 1681 1685 1689 1693 1697 D.	M.	Difference. M.		II. Aft. 1682 1686 1690 1694 1698 D.	M.	Difference. M.	III. Aft. 1683 1687 1691 1695 1699 D.	M.	Difference. M.
1	e	20 ♊ 50	23	13	4	23	12	4	North Declin. Increasing.	23	11	4	23	10	4
2	f	21 47	23	17	3	23	16	3		23	15	4	23	14	4
3	g	22 44	23	20	3	23	19	3		23	19	3	23	18	3
4	a	23 41	23	23	2	23	22	3		23	22	2	23	21	3
5	b	24 38	23	25	2	23	25	2		23	24	2	23	24	2
6	c	25 36	23	27	2	23	27	1		23	26	2	23	26	2
7	d	26 33	23	29	1	23	28	1		23	28	1	23	28	1
8	e	27 30	23	30	1	23	29	1		23	29	1	23	29	1
9	f	28 27	23	31	0	23	30	1		23	30	1	23	30	1
10	g	*Corpus Chr.*	23	*31	0	23	31	0		23	31	0	23	31	0
11	a	*S. Barnab.*	23	31	1	23	*31	0	*	23	*31	0	23	*31	0
12	b	1 ♋ 18	23	30	1	23	31	1		23	31	1	23	31	1
13	c	2 15	23	29	0	23	30	1		23	30	1	23	30	1
14	d	3 12	23	29	2	23	29	2		23	29	1	23	29	1
15	e	4 9	23	27	2	23	27	2		23	28	2	23	28	2
16	f	5 6	23	25	3	23	25	2		23	26	3	23	26	2
17	g	6 3	23	22	3	23	23	3	North Declination Decreasing.	23	23	3	23	24	3
18	a	7 0	23	19	3	23	20	3		23	20	3	23	21	2
19	b	7 57	23	16	4	23	17	4		23	17	4	23	19	4
20	c	8 55	23	12	4	23	13	4		23	13	4	23	15	4
21	d	9 52	23	8	5	23	9	5		23	9	4	23	11	5
22	e	10 48	23	3	5	23	4	5		23	5	4	23	6	4
23	f	11 46	22	58	5	23	0	5		23	1	5	23	2	5
24	g	*S. Jo. Bapt.*	22	53	6	22	55	6		22	56	5	22	57	6
25	a	13 40	22	47	6	22	49	6		22	51	6	22	51	6
26	b	14 27	22	41	7	22	43	7		22	45	7	22	45	6
27	c	15 34	22	34	7	22	36	8		22	38	7	22	39	6
28	d	16 31	22	27	7	22	28	8		22	31	7	22	33	7
29	e	*S. Pet. & P.*	22	20	8	22	22	8		22	34	8	22	26	8
30	f	18 25	22	12		22	14			22	16		22	18	

Tables of the Sun's Right Ascension.

Month Days.	The Sun's Right Ascension. Time. H.	M.	Compl. H.	M.
1	5	19	6	41
2	5	23	6	37
3	5	27	6	33
4	5	31	6	29
5	5	36	6	24
6	5	40	6	20
7	5	44	6	16
8	5	48	6	12
9	5	52	6	8
10	5	56	6	4
11	6	0	6	0
12	6	4	5	56
13	6	8	5	52
14	6	12	5	48
15	6	17	5	43
16	6	21	5	39
17	6	25	5	35
18	6	29	5	31
19	6	33	5	27
20	6	38	5	22
21	6	42	5	18
22	6	46	5	14
23	6	50	5	10
24	6	54	5	6
25	6	58	5	2
26	7	2	4	58
27	7	6	4	54
28	7	10	4	50
29	7	14	4	46
30	7	19	4	41

The LUNAR KALENDAR.

Years of Christ.	☌ ☉ ☾ New Moon. D.	H.	M.	□ ☉ ☾ First Quart. D.	H.	M.	☍ ☉ ☾ Full Moon. D.	H.	M.	□ ☉ ☾ Last Quart. D.	H.	M.
1688	17	8	5 Nig.	25	3	34 Aft.	3	9	56 Nig.	10	5	46 Aft.
1689	7	10	8 Mor.	14	1	51 Aft.	22	4	18 Aft.	30	1	56 Mor.
1690	25	9	21 Mor.	3	6	30 Nig.	11	4	13 Aft.	19	5	43 Aft.
1691	16	2	31 Mor.	22	4	24 Aft.	30	10	26 Mor.	8	10	46 Nig.
1692	4	4	28 Aft.	11	12	37 Noo.	18	2	22 Aft.	26	2	4 Aft.
1693	23	11	56 Mor.	30	3	44 Aft.	8	1	36 Mor.	15	11	37 Mor.
1694	12	3	22 Aft.	20	11	22 Mor.	26	11	51 Nig.	4	1	28 Aft.
1695	1	4	56 Aft.	9	7	56 Nig.	16	6	17 Nig.	23	9	26 Mor.
1696	19	10	32 Mor.	27	12	8 Noo.	5	9	48 Mor.	12	2	42 Mor.
1697	8	6	36 Nig.	16	10	16 Mor.	24	7	0 Mor.	1	11	10 Nig.
1698	27	5	0 Aft.	5	5	32 Mor.	13	12	40 Noo.	27	3	0 Mor.
1699	17	9	32 Mor.	23	11	45 Nig.	2	12	12 Noo.	10	3	16 Aft.

The SOLAR KALENDAR.
JULY.

Tables of the Sun's Declination, *with their* Differences, *for the Years of our Lord.*

Month Days.	Week Days.	Fixed Feasts, and The Sun's Place.	Leap-y. 1680 1684 1688 1692 1696 D.	M.	Difference. M.	I. After. 1681 1685 1689 1693 1697 D.	M.	Difference. M.	North Declination Decreasing.	II. Aft. 1682 1686 1690 1694 1698 D.	M.	Difference. M.	III. Aft. 1683 1687 1691 1695 1699 D.	M.	Difference. M.
1	g	*Visit. Mar.*	22	4	8	22	6	8		22	8	8	22	10	8
2	a	20 ♋ 19	21	56	9	21	58	9		22	0	9	22	2	9
3	b	21 17	21	47	9	21	49	9		21	51	9	21	54	9
4	c	22 14	21	38	10	21	40	10		21	42	9	21	45	10
5	d	23 11	21	28	10	21	31	10		21	33	10	21	35	9
6	e	24 8	21	18	10	21	21	10		21	23	10	21	26	10
7	f	25 5	21	8	11	21	11	11		21	13	10	21	16	11
8	g	26 2	20	57	11	21	0	12		21	3	11	21	5	11
9	a	26 59	20	46	12	20	49	11		20	52	12	20	54	11
10	b	7 *Brethr.*	20	34	11	20	37	12		20	40	11	20	43	12
11	c	28 54	20	23	12	20	26	12		20	29	12	20	31	11
12	d	29 51	20	11	12	20	14	13		20	17	12	20	20	12
13	e	0 ♌ 48	19	59	13	20	2	13		20	5	13	20	8	13
14	f	1 46	19	46	13	19	49	13		19	52	13	19	55	13
15	g	*Swythin.*	19	33	13	19	36	13		19	39	13	19	42	13
16	a	3 40	19	20	14	19	23	14		19	26	13	19	24	13
17	b	4 37	19	6	14	19	10	14		19	13	14	19	16	14
18	c	5 35	18	52	14	18	56	15		18	59	14	19	2	14
19	d	6 32	18	30	15	18	42	15		18	45	15	18	48	14
20	e	*Margaret.*	18	23	15	18	27	15		18	30	15	18	34	15
21	f	8 27	18	8	15	18	12	16		18	15	15	18	19	15
22	g	9 23	17	53	16	17	57	16		18	0	15	18	4	15
23	a	10 21	17	37	16	17	41	16		17	45	16	17	49	16
24	b	11 19	17	21	16	17	25	16		17	29	16	17	23	16
25	c	*James* A.	17	5	16	17	9	16		17	13	16	17	17	16
26	d	13 14	16	49	16	16	53	17		16	57	16	17	1	16
27	e	14 11	16	33	17	16	37	17		16	41	17	16	45	17
28	f	15 9	16	16	17	16	20	18		16	24	17	16	28	17
29	g	16 6	15	59	18	16	3	18		16	7	17	16	11	17
30	a	17 4	15	41	18	15	45	18		15	50	18	15	54	18
31	b	18 1	15	23		15	27			15	32		15	36	

Tables of the Sun's Right Ascension.

Month Days.	The *Sun's Right Ascension.* Time. H.	M.	Compl. H.	M.
1	7	23	4	57
2	7	27	4	33
3	7	31	4	29
4	7	35	4	25
5	7	39	4	21
6	7	43	4	17
7	7	47	4	13
8	7	51	4	9
9	7	55	4	5
10	7	59	4	1
11	8	3	3	57
12	8	7	3	53
13	8	11	3	49
14	8	15	3	45
15	8	19	3	41
16	8	23	3	37
17	8	27	3	33
18	8	31	3	29
19	8	35	3	25
20	8	39	3	21
21	8	43	3	17
22	8	47	3	13
23	8	51	3	9
24	8	55	3	5
25	8	58	3	2
26	9	2	2	58
27	9	6	2	54
28	9	10	2	50
29	9	14	2	46
30	9	18	2	42
31	9	21	2	39

The LUNAR KALENDAR.

Years of Christ.	☌ ☉ ☾ New Moon. D.	H.	M.	□ ☉ ☾ First Quart. D.	H.	M.	☍ ☉ ☾ Full Moon. D.	H.	M.	□ ☉ ☾ Last Quart. D.	H.	M.
1688	17	7	47 Mor.	25	8	34 Mor.	3	8	38 Mor.	10	3	10 Mor.
1689	6	5	28 Aft.	18	1	54 Mor.	22	5	0 Mor.	29	6	7 Mor.
1690	25	4	42 Nig.	3	6	27 Mor.	11	9	28 Mor.	19	2	45 Mor.
1691	15	9	49 Mor.	22	1	43 Mor.	30	1	29 Mor.	8	1	2 Aft.
1692	3	4	25 Mor.	10	5	14 Aft.	18	3	9 Mor.	26	5	51 Mor.
1693	22	11	7 Nig.	29	7	33 Nig.	7	10	40 Mor.	15	4	22 Mor.
1694	12	6	6 Mor.	16	6	1 Nig.	26	8	50 Mor.	4	3	9 Mor.
1695	{ 1 30	7 10	41 M. 50 N. }	9	8	20 Mor.	16	1	10 Mor.	22	8	42 Nig.
1696	18	11	52 Nig.	27	2	56 Mor.	4	6	56 Nig.	11	7	54 Mor.
1697	8	5	0 Mor.	16	3	2 Mor.	23	5	1 Aft.	{ 1 30	11 9	10 N. 10 M. }
1698	27	1	51 Mor.	4	12	55 Nig.	13	2	20 Mor.	20	8	36 Mor.
1699	16	4	38 Aft.	23	4	53 Aft.	{ 2 31	5 7	22 M. 52 N. }	10	2	27 Mor.

The SOLAR KALENDAR.
AUGUST.

Month Days.	Week Days.	Fixed Feasts, and The Sun's Place.	Leap-y. 1680 1684 1688 1692 1696 D.	M.	Difference. M.	I. After 1681 1685 1689 1693 1697 D.	M.	Difference. M.		II. Aft. 1682 1686 1690 1694 1698 D.	M.	Difference. M.	III. Aft. 1683 1687 1691 1695 1699 D.	M.	Difference. M.	Month Days.	The Sun's Right Ascension, Time. H.	M.	Compl. H.	M.
1	c	*Lammas.*	15	5	18	15	10	18	North Declination Decreasing.	15	14	18	15	19	18	1	9	25	2	35
2	d	19 ♌. 56	14	17	18	14	52	18		14	56	18	15	1	19	2	9	29	2	31
3	e	20 54	14	29	19	14	34	19		14	38	19	14	42	18	3	9	33	2	27
4	f	21 52	14	10	19	14	15	19		14	19	19	14	24	19	4	9	37	2	23
5	g	22 49	13	51	19	13	56	19		14	0	19	14	5	19	5	9	40	2	20
6	a	23 47	13	32	19	13	37	19		13	41	19	13	46	19	6	9	44	2	16
7	b	24 45	13	13	19	13	18	19		13	52	19	13	27	19	7	9	48	2	12
8	c	25 43	12	54	20	12	59	20		13	3	20	13	8	20	8	9	51	2	9
9	d	26 40	12	34	19	12	39	20		12	43	20	12	48	20	9	9	55	2	5
10	e	*Laurence.*	12	15	20	12	19	20		12	23	20	12	28	20	10	9	58	2	2
11	f	28 36	11	54	21	11	59	21		12	3	20	12	8	20	11	10	2	1	58
12	g	29 36	11	33	20	11	38	20		11	43	20	11	48	20	12	10	6	1	54
13	a	0 ♍ 32	11	13	21	11	18	21		11	23	20	11	28	21	13	10	10	1	50
14	b	1 30	10	52	20	10	57	21		11	3	21	11	7	20	14	10	14	1	46
15	c	*J.Bapt.* N.	10	32	21	10	36	21		10	42	21	10	47	21	15	10	17	1	43
16	d	3 26	10	11	21	10	15	21		10	21	21	10	26	21	16	10	21	1	39
17	e	4 24	9	50	22	9	54	21		10	0	22	10	5	21	17	10	25	1	35
18	f	5 22	9	28	22	9	33	21		9	38	21	9	44	22	18	10	28	1	32
19	g	6 20	9	6	22	9	12	22		9	17	22	9	22	21	19	10	32	1	28
20	a	7 18	8	44	22	8	50	21		8	55	22	9	1	22	20	10	35	1	25
21	b	8 16	8	23	21	8	29	22		8	33	21	8	39	22	21	10	39	1	21
22	c	9 14	8	1	22	8	7	22		8	12	22	8	17	22	22	10	43	1	17
23	d	10 12	7	39	22	7	45	22		7	50	22	7	55	22	23	10	46	1	14
24	e	*Barthol.* A.	7	17	23	7	23	23		7	28	23	7	33	22	24	10	50	1	10
25	f	12 9	6	56	22	7	0	22		7	5	22	7	11	23	25	10	53	1	7
26	g	13 7	6	32	22	6	38	23		6	43	22	6	45	22	26	10	57	1	3
27	a	14 5	6	10	23	6	15	22		6	21	23	6	26	22	27	0	2	0	58
28	b	15 4	5	47	22	5	53	23		5	58	22	6	4	23	28	0	4	0	56
29	c	16 2	5	25	23	5	30	22		5	35	23	5	41	23	29	0	8	0	52
30	d	17 1	5	2	23	5	8	24		5	13	23	5	13	23	30	0	11	0	49
31	e	17 59	4	39		4	44			4	52		4	55		31	0	15	0	45

Tables of the Sun's Declination, with their Differences, for the Years of our Lord. — Tables of the Sun's Right Ascension.

The LUNAR KALENDAR.

Years of Christ.	☌ ☉ ☾ New Moon. D.	H.	M.		□ ☉ ☾ First Quart. D.	H.	M.		☍ ☉ ☾ Full Moon. D.	H.	M.		□ ☉ ☾ Last Quarter D.	H.	M.	
1688	15	9	10	Nig.	23	12	34	Nig.	1 31	5 2	49 26	Af. M.	8	8	45	Mor.
1689	25	3	21	Mor.	12	11	13	Nig.	20	4	17	Aft.	27	10	38	Mor.
1690	24	1	21	Mor.	1 31	9 2	18 23	Ni. Af.	9	11	49	Nig.	17	9	32	Mor.
1691	13	4	50	Aft.	20	2	22	Aft.	28	5	16	Aft.	7	1	6	Mor.
1692	2 31	9 5	48 49	M. Af.	8	11	44	Nig.	16	5	55	Aft.	24	9	5	Nig.
1693	21	9	26	Mor.	27	12	39	Nig.	5	9	50	Nig.	13	10	0	Nig.
1694	10	7	27	Nig.	17	11	12	Nig.	24	6	30	Nig.	2	7	4	Nig.
1695	29	2	13	Aft.	7	6	20	Nig.	14	8	33	Mor.	21	11	10	Mor.
1696	17	3	10	Aft.	25	4	15	Aft.	2	1	35	Mor.	9	2	36	Aft.
1697	6	5	27	Aft.	14	8	1	Nig.	22	1	54	Mor.	28	3	48	Aft.
1698	25	12	52	Noo.	3	5	40	Aft.	11	2	25	Aft.	18	12	25	Mor.
1699	14	12	32	Nig.	22	8	49	Mor.	30	10	22	Mor.	8	10	10	Mor

The SOLAR KALENDAR.
SEPTEMBER.

Tables of the Sun's Declination, *with their* Differences, *for the Years of our Lord.* — *Tables of the* Sun's Right Ascension.

Month Days.	Week Days.	Fixed Feasts, and The Sun's Place.	Leap-y. 1680 1684 1688 1692 1696 D.	M.	Difference. M.	I. After. 1681 1685 1689 1693 1697 D.	M.	Difference. M.		II. Aft. 1682 1686 1690 1694 1698 D.	M.	Difference. M.	III. Aft. 1683 1687 1691 1695 1699 D.	M.	Difference. M.	Month Days.	The Sun's Right Ascension. Time. H.	M.	Compl. H.	M.
1	f	18 ♍ 58	4	16	23	4	22	23	North Declin. Decreasing.	4	27	23	4	32	23	1	11	19	0	41
2	g	19 56	3	53	23	3	59	24		4	4	23	4	9	23	2	11	23	0	37
3	a	20 55	3	30	23	3	35	23		3	41	24	3	46	23	3	11	26	0	34
4	b	21 53	3	7	24	3	12	23		3	17	23	3	23	23	4	11	30	0	30
5	c	22 52	2	43	23	2	49	23		3	54	23	3	0	23	5	11	33	0	27
6	d	23 51	2	20	23	2	26	23		2	31	23	2	37	24	6	11	37	0	23
7	e	24 49	1	57	24	2	3	24		2	8	23	2	13	23	7	11	41	0	19
8	f	*Mary Nat.*	1	33	23	1	39	23		1	45	24	1	50	23	8	11	44	0	16
9	g	26 47	1	10	24	1	16	24		1	21	23	1	27	24	9	11	46	0	12
10	a	27 46	0	46	23	0	52	23		0	51	24	0	3	24	10	11	51	0	9
11	b	28 44	0	23	22	0	29	24		0	30	24	0	40	24	11	11	55	0	5
12	c	29 43	0	1	23	0	5	24		0	10	7	0	16	9	12	11	59	0	1
13	d	0 ♎ 42	0	*24	24	0	* 8	23	*	0	* 3	23	0	* 7	24	13	0	2	11	58
14	e	*Holy Cross.*	0	48	23	0	42	24	South Declination Increasing.	0	36	26	0	31	23	14	0	6	11	54
15	f	2 40	1	11	24	1	5	24		1	0	23	1	54	24	15	0	9	11	51
16	g	3 39	1	35	23	1	29	23		1	23	24	1	18	23	16	0	13	11	47
17	a	4 38	1	58	24	1	52	24		1	47	23	1	41	24	17	0	17	11	43
18	b	5 37	2	22	23	2	16	24		2	10	24	2	5	23	18	0	20	11	40
19	c	6 36	2	45	24	2	40	23		2	34	23	2	28	24	19	0	24	11	36
20	d	7 36	3	9	23	3	3	24		2	57	24	2	52	23	20	0	27	11	33
21	e	*Matth.* Ap.	3	32	24	3	27	23		3	21	23	3	15	23	21	0	31	11	29
22	f	9 34	3	56	23	3	50	23		3	44	23	3	38	24	22	0	35	11	25
23	g	10 33	4	19	24	4	13	23		4	7	23	4	2	23	23	0	38	11	22
24	a	11 33	4	42	23	4	36	23		4	30	24	4	25	23	24	0	42	11	18
25	b	12 32	5	6	23	4	59	23		4	54	23	4	48	24	25	0	45	11	15
26	c	13 31	5	29	23	5	23	23		5	17	24	5	12	23	26	0	48	11	12
27	d	14 31	5	52	23	5	36	23		5	41	23	5	35	23	27	0	53	11	7
28	e	15 30	6	15	23	6	9	23		6	4	22	5	58	23	28	0	57	11	3
29	f	*Mich.* Arc.	6	38	23	6	32	23		6	26	23	6	21	23	29	1	1	10	59
30	g	17 29	7	1		6	55			6	49		6	44		30	1	4	10	56

The LUNAR KALENDAR.

Years of Christ.	☌ ☉ ☾ New Moon. D.	H.	M.	□ ☉ ☾ First Quart. D.	H.	M.	☍ ☉ ☾ Full Moon. D.	H.	M.	□ ☉ ☾ Last Quart. D.	H.	M.
1688	14	12	49 Noo.	22	3	43 Aft.	29	11	0 Noo	6	4	28 Aft.
1689	3	3	39 Aft.	11	5	17 Aft.	19	5	46 Mor.	25	8	13 Nig.
1690	22	12	32 Noo.	30	9	12 Mor.	8	1	42 Aft.	15	3	8 Aft.
1691	12	1	13 Mor.	19	6	13 Mor.	27	9	8 Mor.	5	11	0 Noo.
1692	30	2	24 Mor.	7	10	4 Mor.	5	10	26 Mor	23	9	13 Mor.
1693	19	7	0 Nig.	25	1	16 Aft.	4	11	34 Noo	12	1	0 Aft.
1694	9	8	10 Mor.	16	5	8 Mor.	23	7	8 Mor	1	12	55 Noo.
1695	28	4	35 Mor.	6	2	5 Mor.	12	5	30 Aft.	2	4	30 Mor.
1696	16	9	46 Mor.	24	3	29 Mor.	{ 1 30	9 8	21 Ni. 52 Af. }	8	5	17 Mor.
1697	5	8	17 Mor.	13	12	0 Noo.	20	10	10 Mor.	27	2	6 Mor.
1698	24	2	29 Mor.	2	12	06 Noo.	10	1	30 Mor.	16	5	1 Aft.
1699	13	10	29 Mor.	21	3	4 Mor.	26	2	10 Mor.	6	4	15 Aft.

The SOLAR KALENDAR. OCTOBER.

Tables of the Sun's Declination, with their Differences, for the Years of our Lord. | Tables of the Sun's Right Ascension.

Week Days	Fixed Feasts, and The Sun's Place.		Leap-y. 1680 1684 1688 1692 1696		Difference.	I. After. 1681 1685 1689 1693 1697		Difference.	II. Aft. 1682 1686 1690 1694 1698		Difference.	III. Aft. 1683 1687 1691 1695 1699		Difference.	Month Days.	The Sun's Right Ascension, Time.		Compl.	
			D.	M.	M.	D.	M.	M.	D.	M.	M.	D.	M.	M.		H.	M.	H.	M.
a	18 ♎	28	7	24	22	7	17	23	7	12	22	7	6	23	1	1	8	10	52
b	19	29	7	46	23	7	40	22	7	35	23	7	29	23	2	1	12	10	48
c	20	28	8	9	22	8	2	23	7	58	22	7	52	23	3	1	15	10	45
d	21	28	8	31	22	8	25	22	8	20	22	8	15	22	4	1	19	10	41
e	22	28	8	53	22	8	47	22	8	42	22	8	37	22	5	1	22	10	38
f	23	27	9	15	22	9	9	23	9	4	23	8	59	21	6	1	26	10	34
g	24	27	9	37	22	9	30	22	9	27	22	9	21	22	7	1	30	10	30
a	25	27	9	59	22	9	54	22	9	49	21	9	43	22	8	1	34	10	26
b	26	27	10	21	22	10	16	21	10	10	22	10	5	22	9	1	38	10	22
c	27	27	10	43	21	10	37	22	10	32	21	10	27	21	10	1	41	10	19
d	28	27	11	4	21	10	59	21	10	53	22	10	48	22	11	1	55	10	15
e	29	27	11	25	21	11	20	21	11	15	21	11	18	21	12	1	49	10	11
f	0 ♏	27	11	46	21	11	41	21	11	36	21	11	31	21	13	1	53	10	7
g	1	27	12	7	21	12	2	21	11	57	21	11	52	23	14	1	57	10	3
a	2	27	12	28	20	12	23	21	12	18	21	12	15	21	15	2	0	10	0
b	3	27	12	48	21	12	44	20	12	39	20	12	34	20	16	2	4	9	56
c	4	27	13	9	20	13	4	20	12	59	21	12	54	20	17	2	8	9	52
d	*Luke* Eva.		13	29	20	13	24	20	13	20	20	13	14	20	18	2	12	9	48
e	6	27	13	49	20	13	44	20	13	40	19	13	34	20	19	2	16	9	44
f	7	27	14	9	19	14	4	20	13	59	20	13	54	29	20	2	20	9	40
g	8	28	14	28	20	14	24	19	14	19	19	14	14	20	21	2	24	9	36
a	9	28	14	48	19	14	43	19	14	38	19	14	34	19	22	2	28	9	32
b	10	28	15	7	19	15	2	19	14	57	19	14	53	19	23	2	32	9	28
c	11	29	15	26	18	15	21	19	15	16	19	15	12	19	24	2	36	9	24
d	*Crispine.*		15	44	18	15	40	18	15	35	18	15	31	18	25	2	39	9	21
e	13	29	16	2	18	15	58	18	15	53	18	15	49	18	26	2	43	9	17
f	14	30	16	20	17	16	16	17	16	11	18	16	7	18	27	2	47	9	13
g	*Sim.*& *Ju.*		16	38	17	16	33	18	16	29	18	16	25	17	28	2	51	9	9
a	16	31	16	55	17	16	51	17	16	45	17	16	32	18	29	2	55	9	5
b	17	31	17	12	17	17	8	17	17	4	17	17	0	17	30	2	59	9	1
c	18	32	17	29		17	25		17	21		17	17		31	3	3	8	57

South Declination Increasing.

The LUNAR KALENDAR.

Years of Christ.	☌ ☉ ☾ New Moon. D.	H.	M.		□ ☉ ☾ First Quart. D.	H.	M.		☍ ☉ ☾ Full Moon. D.	H.	M.		□ ☉ ☾ Last Quarter D.	H.	M.	
1688	14	6	40	Mor.	22	5	0	Mor.	28	8	12	Nig.	6	4	56	Mor.
1689	3	6	45	Mor.	11	11	0	Noo.	18	12	40	Noo.	25	2	21	Mor.
1690	22	1	10	Mor.	30	3	19	Mor.	8	2	26	Mor.	14	10	35	Nig.
1691	11	1	4	Aft.	19	1	9	Aft.	26	12	29	Nig.	4	6	42	Nig.
1692	29	12	36	Noo.	6	12	30	Nig.	15	3	52	Mor.	22	9	32	Nig.
1693	19	4	17	Mor.	25	9	10	Nig.	4	3	41	Mor.	12	7	25	Mor.
1694	8	7	32	Nig.	15	10	48	Mor.	22	10	34	Nig.	31	2	36	Mor.
1695	26	7	0	Nig.	4	9	26	Nig.	12	4	45	Mor.	19	12	0	Nig.
1696	15	12	0	Nig.	23	12	52	Noo.	30	4	30	Mor.	7	9	23	Nig.
1697	5	1	7	Mor.	13	2	40	Mor.	19	7	4	Nig.	27	2	28	Mor.
1698	23	7	24	Nig.	{2 {31	5 11	53 20	M.} Ni.}	9	12	2	Noo.	16	2	3	Mor.
1699	12	10	41	Mor.	20	10	43	Nig.	28	12	26	Noo.	5	9	47	Nig.

The SOLAR KALENDAR.
SEPTEMBER.

Tables of the Sun's Declination, *with their* Differences, *for the Years of our Lord.* | *Tables of the* Su[n's] Right Ascensio[n]

Month Days.	Week Days.	Fixed Feasts, and The Sun's Place.		Leap-y. 1680 1684 1688 1692 1696		Difference.	I. After. 1681 1685 1689 1693 1697		Difference.		II. Aft. 1682 1686 1690 1694 1698		Difference.	III. Aft. 1683 1687 1691 1695 1699		Difference.	Month Days.	The *Sun's Ri[ght] Ascension.* Time.		Comp[...]	
				D.	M.	M.	D.	M.	M.		D.	M.	M.	D.	M.	M.		H.	M.	H.	M
1	f	18 ♍	58	4	16	23	4	22	23	North Declin. Decreasing.	4	27	23	4	32	23	1	11	19	0	
2	g	19	56	3	53	23	3	59	24		4	4	23	4	9	23	2	11	23	0	
3	a	20	55	3	30	23	3	35	23		3	41	24	3	46	23	3	11	26	0	
4	b	21	53	3	7	24	3	12	23		3	17	23	3	23	23	4	11	30	0	
5	c	22	52	2	43	23	2	49	23		3	54	23	3	0	23	5	11	33	0	
6	d	23	51	2	20	23	2	26	23		2	31	23	2	37	24	6	11	37	0	
7	e	24	49	1	57	24	2	3	24		2	8	23	2	13	23	7	11	41	0	
8	f	*Mary Nat.*		1	33	23	1	39	23		1	45	24	1	50	23	8	11	44	0	
9	g	26	47	1	10	24	1	16	24		1	21	23	1	27	24	9	11	46	0	
10	a	27	46	0	46	23	0	52	23		0	51	24	0	3	24	10	11	51	0	
11	b	28	44	0	23	22	0	29	24		0	30	24	0	40	24	11	11	55	0	
12	c	29	43	0	1	23	0	5	24		0	10	7	0	16	9	12	11	59	0	
13	d	0 ♎	42	0	*24	24	0	* 8	23	*	0	* 3	23	0	* 7	24	13	0	2	11	
14	e	*Holy Cross.*		0	48	23	0	42	24	South Declination Increasing.	0	36	26	0	31	23	14	0	6	11	
15	f	2	40	1	11	24	1	5	24		1	0	23	1	54	24	15	0	9	11	
16	g	3	39	1	35	23	1	29	23		1	23	24	1	18	23	16	0	13	11	
17	a	4	38	1	58	24	1	52	24		1	47	23	1	41	24	17	0	17	11	
18	b	5	37	2	22	23	2	16	24		2	10	24	2	5	23	18	0	20	11	
19	c	6	36	2	45	24	2	40	23		2	34	23	2	28	24	19	0	24	11	
20	d	7	36	3	9	23	3	3	24		2	57	24	2	52	23	20	0	27	11	
21	e	*Matth.* Ap.		3	32	24	3	27	23		3	21	23	3	15	23	21	0	31	11	
22	f	9	34	3	56	23	3	50	23		3	44	23	3	38	24	22	0	35	11	
23	g	10	33	4	19	24	4	13	23		4	7	23	4	2	23	23	0	38	11	
24	a	11	33	4	42	23	4	36	23		4	30	24	4	25	23	24	0	42	11	
25	b	12	32	5	6	23	4	59	23		4	54	23	4	48	24	25	0	45	11	
26	c	13	31	5	29	23	5	23	23		5	17	24	5	12	23	26	0	48	11	
27	d	14	31	5	52	23	5	36	23		5	41	23	5	35	23	27	0	53	11	
28	e	15	30	6	15	23	6	9	23		6	4	22	5	58	23	28	0	57	11	
29	f	*Mich.* Arc.		6	38	23	6	32	23		6	26	23	6	21	23	29	1	1	10	
30	g	17	29	7	1		6	55			6	49		6	44		30	1	4	10	

The LUNAR KALENDAR.

Years of Christ.	☌ ☉ ☾ New Moon. D.	H.	M.		□ ☉ ☾ First Quart. D.	H.	M.		☍ ☉ ☾ Full Moon. D.	H.	M.		□ ☉ ☾ Last Quart. D.	H.	M.	
1688	14	12	49	Noo.	22	3	43	Aft.	29	11	0	Noo	6	4	28	Aft.
1689	3	3	39	Aft.	11	5	17	Aft.	19	5	46	Mor.	25	8	13	Nig.
1690	22	12	32	Noo.	30	9	12	Mor.	8	1	42	Aft.	15	3	8	Aft.
1691	12	1	13	Mor.	19	6	13	Mor.	27	9	8	Mor.	5	11	0	No
1692	30	2	24	Mor.	7	10	4	Mor.	5	10	26	Mor	23	9	13	Mo
1693	19	7	0	Nig.	25	1	16	Aft.	4	11	34	Noo	12	1	0	Aft.
1694	9	8	10	Mor.	16	5	8	Mor.	23	7	8	Mor	1	12	55	No
1695	28	4	35	Mor.	6	2	5	Mor.	12	5	30	Aft.	2	4	30	Mo
1696	16	9	46	Mor.	24	3	29	Mor.	1 30	9 8	21 52	Ni. Af.	8	5	17	Mo
1697	5	8	17	Mor.	13	12	0	Noo.	20	10	10	Mor.	27	2	6	Mo
1698	24	2	29	Mor.	2	12	06	Noo.	10	1	30	Mor.	16	5	1	Aft.
1699	13	10	29	Mor.	21	3	4	Mor.	26	2	10	Mor.	6	4	15	Aft.

The SOLAR KALENDAR.
OCTOBER.

Tables of the Sun's Declination, *with their* Differences, *for the Years of our Lord.*

Month Days.	Week Days.	Fixed Feasts, and The Sun's Place.	Leap-y. 1680 1684 1688 1692 1696		Difference.	I. After. 1681 1685 1689 1693 1697		Difference.		II. Aft. 1682 1686 1690 1694 1698		Difference.	III. Aft. 1683 1687 1691 1695 1699		Difference.
			D.	M.	M.	D.	M.	M.		D.	M.	M.	D.	M.	M.
1	a	18 ♎ 28	7	24	22	7	17	23		7	12	22	7	6	23
2	b	19 29	7	46	23	7	40	22		7	35	23	7	29	23
3	c	20 28	8	9	22	8	2	23		7	58	22	7	52	23
4	d	21 28	8	31	22	8	25	22		8	20	22	8	15	22
5	e	22 28	8	53	22	8	47	22		8	42	22	8	37	22
6	f	23 27	9	15	22	9	9	23		9	4	23	8	59	21
7	g	24 27	9	37	22	9	30	22		9	27	22	9	21	22
8	a	25 27	9	59	22	9	54	22		9	49	21	9	43	22
9	b	26 27	10	21	22	10	16	21		10	10	22	10	5	22
10	c	27 27	10	43	21	10	37	22		10	32	21	10	27	21
11	d	28 27	11	4	21	10	59	21	South Declination Increasing.	10	53	22	10	48	22
12	e	29 27	11	25	21	11	20	21		11	15	21	11	18	21
13	f	0 ♏ 27	11	46	21	11	41	21		11	36	21	11	31	21
14	g	1 27	12	7	21	12	2	21		11	57	21	11	52	23
15	a	2 27	12	28	20	12	23	21		12	18	21	12	15	21
16	b	3 27	12	48	21	12	44	20		12	39	20	12	34	20
17	c	4 27	13	9	20	13	4	20		12	59	21	12	54	20
18	d	*Luke* Eva.	13	29	20	13	24	20		13	20	20	13	14	20
19	e	6 27	13	49	20	13	44	20		13	40	19	13	34	20
20	f	7 27	14	9	19	14	4	20		13	59	20	13	54	29
21	g	8 28	14	28	20	14	24	19		14	19	19	14	14	20
22	a	9 28	14	48	19	14	43	19		14	38	19	14	34	19
23	b	10 28	15	7	19	15	2	19		14	57	19	14	53	19
24	c	11 29	15	26	18	15	21	19		15	16	19	15	12	19
25	d	*Crispine.*	15	44	18	15	40	18		15	35	18	15	31	18
26	e	13 29	16	2	18	15	58	18		15	53	18	15	49	18
27	f	14 30	16	20	17	16	16	17		16	11	18	16	7	18
28	g	*Sim.&* *Ju.*	16	38	17	16	33	18		16	29	18	16	25	17
29	a	16 31	16	55	17	16	51	17		16	45	17	16	32	18
30	b	17 31	17	12	17	17	8	17		17	4	17	17	0	17
31	c	18 32	17	29		17	25			17	21		17	17	

Tables of the Sun's Right Ascension.

Month Days.	The *Sun's Right Ascension,* Time.		Compl.	
	H.	M.	H.	M.
1	1	8	10	52
2	1	12	10	48
3	1	15	10	45
4	1	19	10	41
5	1	22	10	38
6	1	26	10	34
7	1	30	10	30
8	1	34	10	26
9	1	38	10	22
10	1	41	10	19
11	1	55	10	15
12	1	49	10	11
13	1	53	10	7
14	1	57	10	3
15	2	0	10	0
16	2	4	9	56
17	2	8	9	52
18	2	12	9	48
19	2	16	9	44
20	2	20	9	40
21	2	24	9	36
22	2	28	9	32
23	2	32	9	28
24	2	36	9	24
25	2	39	9	21
26	2	43	9	17
27	2	47	9	13
28	2	51	9	9
29	2	55	9	5
30	2	59	9	1
31	3	3	8	57

The LUNAR KALENDAR.

Years of Christ.	☌ ☉ ☾ New Moon. D.	H.	M.		□ ☉ ☾ First Quart. D.	H.	M.		☍ ☉ ☾ Full Moon. D.	H.	M.		□ ☉ ☾ Last Quarter D.	H.	M.	
1688	14	6	40	Mor.	22	5	0	Mor.	28	8	12	Nig.	6	4	56	Mor.
1689	3	6	45	Mor.	11	11	0	Noo.	18	12	40	Noo.	25	2	21	Mor.
1690	22	1	10	Mor.	30	3	19	Mor.	8	2	26	Mor.	14	10	35	Nig.
1691	11	1	4	Aft.	19	1	9	Aft.	26	12	29	Nig.	4	6	42	Nig.
1692	29	12	36	Noo.	6	12	30	Nig.	15	3	52	Mor.	22	9	32	Nig.
1693	19	4	17	Mor.	25	9	10	Nig.	4	3	41	Mor.	12	7	25	Mor.
1694	8	7	32	Nig.	15	10	48	Mor.	22	10	34	Nig.	31	2	36	Mor.
1695	26	7	0	Nig.	4	9	26	Nig.	12	4	45	Mor.	19	12	0	Nig.
1696	15	12	0	Nig.	23	12	52	Noo.	30	4	30	Mor.	7	9	23	Nig.
1697	5	1	7	Mor.	13	2	40	Mor.	19	7	4	Nig.	27	2	28	Mor.
1698	23	7	24	Nig.	{2 {31	5 11	53 20	M.} Ni.}	9	12	2	Noo.	16	2	3	Mor.
1699	12	10	41	Mor.	20	10	43	Nig.	28	12	26	Noo.	5	9	47	Nig.

The SOLAR KALENDAR.
NOVEMBER.

Tables of the Sun's Declination, *with their* Differences, *for the Years of our Lord.* — *Tables of the* Sun's Right Ascension.

Month Days.	Week Days.	Fixed Feasts, and The Sun's Place.	Leap-y. 1680 1684 1688 1692 1696 D.	M.	Difference. M.	I. After. 1681 1685 1689 1693 1697 D.	M.	Difference. M.	II. Aft. 1682 1686 1690 1694 1698 D.	M.	Difference. M.	III. Aft. 1683 1687 1691 1695 1699 D.	M.	Difference. M.	Month Days.	The Sun's Right Ascension. Time. H.	M.	Compl. H.	M.
1	d	*All Saints.*	17	46	16	17	41	17	17	38	16	17	32	17	1	3	7	8	53
2	e	20 ♏ 33	18	2	16	17	58	16	17	54	16	17	50	16	2	3	11	8	49
3	f	21 34	18	18	15	18	1	16	18	10	16	18	6	16	3	3	15	8	45
4	g	23 35	18	33	15	18	30	15	18	26	15	18	22	15	4	3	19	8	41
5	a	*Powd. Tr.*	18	48	15	18	45	15	18	41	15	18	37	16	5	3	23	8	37
6	b	24 36	19	3	15	19	0	14	18	56	15	19	53	15	6	3	27	8	33
7	c	25 37	19	18	14	19	14	14	19	11	14	19	8	14	7	3	31	8	29
8	d	26 37	19	32	14	19	29	14	19	25	14	19	22	14	8	3	36	8	24
9	e	27 38	19	46	13	19	43	13	19	39	14	19	36	14	9	3	40	8	20
10	f	*Martin.*	19	59	14	19	56	14	19	53	13	19	50	13	10	3	45	8	15
11	g	29 40	20	13	13	20	10	13	20	6	13	20	3	13	11	3	49	8	11
12	a	0 ♐ 41	20	26	12	20	23	12	20	19	12	20	16	13	12	3	53	8	7
13	b	1 42	20	38	12	20	35	12	20	31	12	20	29	12	13	3	58	8	2
14	c	2 43	20	50	12	20	47	12	20	43	12	20	41	12	14	4	2	7	58
15	d	3 43	21	2	11	20	59	11	20	55	12	20	53	12	15	4	7	7	53
16	e	*Hugh.*	21	13	10	21	10	11	21	7	11	21	5	11	16	4	11	7	49
17	f	5 45	21	23	9	21	21	10	21	18	11	21	16	10	17	4	15	7	45
18	g	6 46	21	34	10	21	31	10	21	29	10	21	26	10	18	4	19	7	41
19	a	7 47	21	44	10	21	41	10	21	39	10	21	36	10	19	4	23	7	37
20	b	8 48	21	54	9	21	51	9	21	49	9	21	46	10	20	4	28	7	32
21	c	9 49	22	3	8	22	0	9	21	58	9	22	56	9	21	4	32	7	28
22	d	10 50	22	11	8	22	9	9	22	7	9	22	5	8	22	4	36	7	24
23	e	11 52	22	20	8	22	18	8	22	10	8	22	13	9	23	4	40	7	20
24	f	*Katherine.*	22	28	7	22	26	8	22	24	7	22	22	8	24	4	45	7	15
25	g	13 54	22	35	7	22	34	7	22	31	8	22	30	7	25	4	49	7	11
26	a	14 55	22	42	6	22	41	7	22	39	6	22	37	7	26	4	53	7	7
27	b	15 56	22	48	6	22	48	6	22	45	7	22	44	6	27	4	57	7	3
28	c	16 57	22	54	6	22	54	5	22	52	6	22	50	6	28	5	2	6	58
29	d	17 58	23	0	5	22	59	5	22	58	5	22	56	6	29	5	6	6	54
30	e	*Andr.* Ap.	23	5		23	4		23	3		23	2		30	5	11	6	49

South Declination Increasing.

The LUNAR KALENDAR.

Years of Christ.	☌ ☉ ☾ New Moon. D.	H.	M.		□ ☉ ☾ First Quart. D.	H.	M.		□ ☉ ☾ Last Quart. D.	H.	M.		☍ ☉ ☾ Full Moon. D.	H.	M.	
1688	12	12	52	Nig.	20	4	8	Aft.	27	7	5	Mor	4	2	51	Aft.
1689	1	12	35	Nig.	10	3	35	Mor.	16	10	30	Nig.	23	5	22	Aft.
1690	20	7	34	Nig.	28	9	51	Nig.	6	12	25	Noo	13	4	52	Mor.
1691	9	12	15	Nig.	17	9	44	Nig.	25	2	30	Aft.	3	1	42	Mor.
1692	27	11	48	Nig.	5	6	46	Nig.	13	9	46	Nig.	21	6	43	Mor.
1693	17	2	9	Aft.	24	12	42	Noo.	2	9	16	Nig.	10	10	2	Nig.
1694	7	6	20	Mor.	13	8	46	Nig.	21	4	42	Aft.	{ 1 { 29	7 8	44 14	Ni. } Ni. }
1695	26	4	7	Mor.	3	3	10	Aft.	10	7	0	Nig.	18	10	37	Nig.
1696	14	5	12	Aft.	21	8	16	Nig.	28	5	22	Aft.	6	4	31	Aft.
1697	3	7	46	Nig.	11	3	13	Aft.	18	5	51	Mor.	25	10	14	Mor.
1698	22	2	10	Aft.	30	3	16	Aft.	7	10	0	Nig.	14	2	3	Aft.
1699	11	2	43	Aft.	19	6	37	Nig.	26	12	3	Nig.	3	8	25	Nig.

The SOLAR KALENDAR.
DECEMBER.

Month Days.	Week Days.	Fixed Feasts, and The Sun's Place.	Leap-y. 1680 1684 1688 1692 1696 D.	M.	Difference. M.	I. After. 1681 1685 1689 1693 1697 D.	M.	Difference. M.		II. Aft. 1682 1686 1690 1694 1698 D.	M.	Difference. M.	III. Aft. 1683 1687 1691 1695 1699 D.	M.	Difference. M.	Month Days.	The Sun's Right Ascension, Time. H.	M.	Compl. H.	M.
1	f	20 ♐ 1	23	10	4	23	9	4	South Decl. Increasing.	23	8	4	23	6	5	1	5	15	6	45
2	g	21 2	23	14	4	23	13	4		23	12	4	23	11	4	2	5	21	6	39
3	a	22 3	23	18	3	23	17	3		23	16	4	23	15	4	3	5	25	6	35
4	b	23 4	23	21	3	23	20	3		23	20	3	23	18	3	4	5	29	6	31
5	c	24 6	23	24	2	23	23	3		23	23	3	23	22	2	5	5	34	6	26
6	d	*Nicholas.*	23	26	2	23	26	2		23	25	2	23	25	2	6	5	38	6	22
7	e	26 8	23	28	2	23	28	1		23	27	2	23	27	1	7	5	42	6	18
8	f	27 9	23	30	1	23	29	1		23	29	1	23	28	2	8	5	47	6	13
9	g	28 11	23	31	0	23	30	1		23	30	1	23	30	1	9	5	51	6	9
10	a	29 12	23	* 31	0	23	* 31	0	*	23	* 31	0	23	* 31	0	10	5	56	6	4
11	b	0 ♑ 13	23	31	1	23	31	0		23	31	0	23	31	0	11	6	0	6	0
12	c	1 14	23	30	1	23	31	1		23	31	1	23	31	1	12	6	5	5	55
13	d	*Lucy.*	23	29	1	23	30	2		23	30	1	23	30	1	13	6	9	5	51
14	e	3 17	23	28	2	23	29	2		23	29	2	23	29	2	14	6	14	5	46
15	f	4 18	23	26	2	23	27	2	North Declination Decreasing.	23	27	2	23	27	2	15	6	19	5	41
16	g	5 20	23	24	3	23	25	3		23	25	3	23	25	2	16	6	24	5	36
17	a	6 21	23	21	3	23	22	3		23	22	3	23	23	3	17	6	28	5	32
18	b	7 22	23	18	4	23	19	4		23	19	4	23	20	4	18	6	33	5	27
19	c	8 23	23	14	5	23	15	5		23	16	4	23	16	4	19	6	37	5	23
20	d	9 25	23	9	4	23	10	6		23	12	5	23	12	4	20	6	41	5	19
21	e	S. *Tho.* Ap.	23	5	5	23	6	6		23	7	5	23	8	5	21	6	45	5	15
22	f	11 27	23	0	4	23	1	6		23	2	5	23	3	5	22	6	48	5	12
23	g	12 28	22	54	5	22	55	7		22	57	6	22	54	6	23	6	54	5	6
24	a	13 29	22	48	6	22	49	8		22	51	6	22	52	6	24	6	58	5	2
25	b	*Christ. N.*	22	41	6	22	43	8		22	45	7	22	46	7	25	7	3	4	57
26	c	S. *Stephen.*	22	34	7	22	36	8		22	38	7	22	39	7	26	7	7	4	53
27	d	S. *Joh.* Ev.	22	27	7	22	28	8		22	31	8	22	32	7	27	7	11	4	49
28	e	*Innocents.*	22	19	8	22	20	8		22	23	8	22	25	8	28	7	16	4	44
29	f	18 35	22	11	8	22	12	9		22	15	9	22	17	9	29	7	20	4	40
30	g	19 37	22	9	8	22	4	9		22	6	9	22	8	9	30	7	25	4	35
31	a	20 38	21	53		21	55			21	57		31	59		31	7	30	4	30

Tables of the Sun's Declination, with their Differences, for the Years of our Lord. Tables of the Sun's Right Ascension.

The LUNAR KALENDAR.

Years of Christ.	☌ ☉ ☾ New Moon. D.	H.	M.		□ ☉ ☾ First Quart. D.	H.	M.		☍ ☉ ☾ Full Moon. D.	H.	M.		□ ☉ ☾ Last Quarter D.	H.	M.	
1688	12	7	0	Nig.	20	1	2	Mor.	26	7	42	Nig.	4	6	15	Nig.
1689	1	1	4	Af.	9	6	0	Nig.	16	10	2	Mor.	23	10	42	Mor.
	31	3	2	Af.												
1690	20	2	42	Aft.	28	5	5	Nig.	6	1	12	Mor.	12	4	25	Aft.
1691	9	1	51	Aft.	17	6	33	Nig.	25	3	9	Mor.	2	10	54	M.
													31	4	29	Af.
1692	27	1	35	Aft.	5	2	40	Aft.	13	1	50	Aft.	20	12	46	Noo.
1693	16	11	17	Nig.	24	8	3	Mor.	2	5	16	Aft.	10	10	28	Mor.
1694	6	4	43	Aft.	13	10	20	Mor.	21	12	8	Noo.	29	11	31	Noo.
1695	25	6	11	Nig.	3	11	12	Nig.	10	12	0	Noo.	18	4	25	Aft.
1696	14	8	4	Mor.	21	3	49	Mor.	28	8	49	Mor.	6	12	42	Noo.
1697	3	2	0	Aft.	11	1	25	Mor.	17	5	31	Nig.	25	6	8	Mor.
1698	22	9	37	Mor.	30	4	0	Mor.	7	7	54	Mor.	14	5	48	Mor.
1699	11	8	51	Mor.	19	12	56	Noo.	26	11	00	Mor.	3	8	11	Mor.

A TABLE whereby to appropriate the Tables of the Sun's Declination *to any Hour of the Day, or to any other* Meridian, *either Eastward or Westward of* London, *for which they were Calculated.*

Hours and Minutes after Noon, till Midnight.

The Difference of the Sun's Declination in Min. in 24 Hours.	1		2		3		4		5		6		7		8		9		10		11		Midn.	
	M.	Sec.	M.	Sec.	M.	Sec.	M.	Sec.	M.	Sec.	M.	Sec.	M.	Sec.	M.	Sec.	M.	Sec.	M.	Sec.	M.	Sec.	M.	Sec.
1	0	2	0	5	0	5	0	10	0	12	0	15	0	17	0	20	0	20	0	25	0	27	0	30
2	0	5	0	10	0	15	0	20	0	25	0	30	0	55	0	40	0	45	0	50	0	55	1	0
3	0	7	0	15	0	22	0	30	0	37	0	45	0	52	1	0	1	7	1	15	1	22	1	30
4	0	10	0	20	0	30	0	40	0	50	1	0	1	10	1	20	1	30	1	40	1	50	2	0
5	0	12	0	25	0	37	0	50	1	2	1	15	1	27	1	40	1	52	2	5	2	17	2	30
6	0	15	0	30	0	45	1	0	1	15	1	30	1	45	2	0	2	15	2	30	2	45	3	0
7	0	17	0	35	0	52	1	10	1	27	1	45	2	2	2	20	2	37	2	55	3	12	3	30
8	0	20	0	40	1	0	1	20	1	40	2	0	2	20	2	40	3	0	3	20	3	40	4	0
9	0	22	0	45	1	7	1	30	1	52	2	15	2	37	3	0	3	22	3	45	4	7	4	30
10	0	25	0	50	1	15	1	40	2	5	2	30	2	55	3	20	3	45	4	10	4	35	5	0
11	0	27	0	55	1	22	1	50	2	17	2	45	3	12	3	40	4	7	4	35	5	2	5	30
12	0	30	1	0	1	30	2	0	2	30	3	0	3	30	4	0	4	30	5	0	5	30	6	0
13	0	32	1	5	1	37	2	10	2	42	3	15	3	47	4	20	4	52	5	25	5	57	6	30
14	0	35	1	10	1	45	2	20	2	55	3	30	4	5	4	40	5	15	5	50	6	25	7	0
15	0	37	1	15	1	52	2	30	3	7	3	45	4	22	5	0	5	37	6	15	5	52	7	30
16	0	40	1	20	2	0	2	40	3	20	4	0	4	40	5	20	6	0	6	40	7	20	8	0
17	0	42	1	25	2	7	2	50	3	32	4	15	4	57	5	40	6	22	7	5	7	47	8	30
18	0	45	1	30	2	15	3	0	3	45	4	30	5	15	6	0	6	45	7	30	8	15	9	0
19	0	47	1	35	2	22	3	10	3	57	4	45	5	32	6	20	7	7	7	55	8	42	9	30
20	0	50	1	40	2	30	3	20	4	10	5	0	5	50	6	40	7	30	8	20	9	10	10	0
21	0	52	1	45	2	37	3	30	4	22	5	15	6	7	7	0	7	52	8	45	9	37	10	30
22	0	55	1	50	2	45	3	40	4	35	5	30	6	25	7	20	8	15	9	10	10	5	11	0
23	0	57	1	55	2	52	3	50	4	47	5	45	6	42	7	40	8	37	9	35	10	32	11	30
24	1	0	2	0	3	0	4	0	5	0	6	0	7	0	8	0	9	0	10	0	11	0	12	0

Hours and Minutes from Midnight, till the next Morning.

The Difference of the Sun's Declination in 24 Hours.	1		2		3		4		5		6		7		8		9		10		11	
	M.	Sec.	M.	Sec.	M.	Sec.	M.	Sec.	M.	Sec.	M.	Sec.	M.	Sec.	M.	Sec.	M.	Sec.	M.	Sec	M.	Sec.
1	0	32	0	35	0	37	0	40	0	42	0	45	0	47	0	50	0	52	0	55	0	57
2	1	5	1	10	1	15	1	20	1	25	1	30	1	35	1	40	1	45	1	50	1	55
3	1	37	1	45	0	52	2	0	2	7	2	15	2	22	2	30	2	37	2	45	2	52
4	2	10	2	20	2	30	2	40	2	50	3	0	3	10	3	20	3	30	3	40	3	50
5	2	42	2	30	3	4	3	20	3	32	3	45	3	57	4	10	4	22	4	35	5	47
6	3	15	3	30	3	45	4	0	4	15	4	30	4	45	5	0	5	15	5	30	5	45
7	3	47	4	5	4	22	4	40	4	57	5	15	5	32	5	50	6	7	6	25	6	42
8	4	20	4	40	5	0	5	20	5	40	6	0	6	20	6	40	7	0	7	20	7	40
9	4	52	5	15	5	37	6	0	6	22	6	45	7	7	6	30	7	52	8	15	8	37
10	5	25	5	50	6	15	6	40	7	5	7	30	7	55	8	20	8	45	9	10	9	35
11	5	57	6	25	6	52	7	20	7	47	8	15	8	42	9	10	9	37	10	5	10	32
12	6	30	7	0	7	30	8	0	8	30	9	0	9	30	10	0	10	30	11	0	11	30
13	7	2	7	35	8	7	8	40	9	12	9	45	10	17	10	50	11	22	11	55	12	27
14	7	35	8	10	8	45	9	20	9	55	10	30	11	5	11	40	12	15	12	50	13	25
15	8	7	8	45	9	22	10	0	10	37	11	15	11	52	12	30	12	67	13	45	14	22
16	8	40	9	20	10	0	10	40	11	20	12	0	12	40	13	20	14	0	14	40	15	20
17	9	12	9	55	10	37	11	20	12	2	12	45	13	27	14	10	14	52	15	35	16	17
18	9	45	10	30	11	15	12	0	12	45	13	30	14	19	15	0	15	45	16	30	17	15
19	10	17	11	5	11	52	12	40	13	27	14	15	15	2	15	50	16	37	17	25	18	12
20	10	50	11	40	12	30	13	20	14	10	15	0	15	50	16	40	17	30	18	20	19	10
21	11	22	12	15	13	7	14	0	14	52	15	45	16	37	17	30	18	22	19	15	20	7
22	11	55	12	50	13	45	14	40	15	35	16	30	17	25	18	20	19	15	20	10	21	5
23	12	27	13	25	14	22	15	20	16	17	17	15	18	12	19	10	20	7	21	5	22	2
24	13	0	14	0	15	0	16	0	17	0	18	0	19	0	20	0	21	0	22	0	23	0

The

The Use of the Table of Referring the Sun's Declination *to any* Hour *or* Meridian.

THE Tables of the *Sun's Declination* in the foregoing *Kalendar*, are calculated properly for the Sun's true Place at Noon in the *Meridian* of *London*; but may be referred to any other *Meridian*, by help of this Table.

Also take notice, That the Degrees and Minutes of *Declination* found against every Day of the Year, are the Degrees and Minutes which the *Sun* hath every Day at Noon, for the *Astronomical Account* of *Days* is from *Noon* to *Noon*; so that One in the Afternoon is called the First Hour after Noon, Two the Second, Three the Third, *&c.* till Twelve at Night, or Midnight. Then One in the Morning is called the Thirteenth Hour, or the First Hour from midnight; Two in the Morning the Fourteenth Hour, or the Second Hour from Midnight, *&c.* So that Eleven the next Forenoon is called the Twenty third Hour, or the Eleventh Hour from Midnight; and then at Twelve begins the next Day.

Also observe, That when you make use of the Table of *Declination*, you make use of the Degrees and Minutes found against the Tenth day, till the Eleventh day at Noon; and of those against the Eleventh day, till the Twelfth day at Noon, *&c.* These things being premised, the Use of the Table follows.

How to Appropriate the Sun's Declination *to any Hour after Noon.*

You must first find the *Sun's Declination* for the Day proposed, (in its proper Year,) in the Table, and note it down, with the *Difference* between that and the next day; then knowing at what Hour after Noon you would make use of the *Declination*, find that Hour in the Head of this Table, and the Minutes of the *Difference* of the *Sun's Declination* in the First Column towards the Left-hand, and in the common *Angle* or Meeting of those two, you shall find the Number of *Minutes* and *Seconds* which are to be added to, or subtracted from the *Degrees* and *Minutes* found in the Table: To be added, if the *Declination* increase; but to be subtracted, if the *Declination* do decrease.

Example. *What* Declination *shall the* Sun *have upon the Fifth of* April, *at Seven Hours after Noon, in the* Leap-year?

Look in the Table for the Fifth of *April*, and against it, in the Column (*Leap-year*) you shall find 10 deg. 6 min for the *Declination*, and 21 min. for the *Difference*: Now the *Declination* found, 10 deg. 6 min. is the *Declination* at Twelve at Noon; but to find it at Seven after Noon, go to this Table, and find 7 Hours at the Head thereof, and 21 (the *Difference*) in the first Column towards the Right-hand, and against 21, and under 7 Hours, you shall find 6 *Minutes* 7 *Seconds*; the *Seconds*, being under 30, may be omitted; but the 6 *Minutes* must be added (because the *Declination* increaseth) to the *Declination* at Noon, 10 deg. 6 min. making it 10 deg. 12 min. and such *Declination* shall the *Sun* have on the Fifth of *April* at Seven in the Afternoon, in the *Leap-year*.

In like manner, if it were required to find what *Declination* the *Sun* should have the same day at 19 Hours after Noon, that is, the Seventh Hour after Midnight, or Seven the next Morning: The Hour 7 being found in the Head of the Table, and 21 min. (the *Difference* of *Declination*) in the first Column, against 21, and under 7 Hours, you shall find 16 min. 37 sec. which *Seconds* being above 30, add 1 min. to 16, making it 17 min. which added to 10 deg. 6 min. the *Declination* found in the Table, maketh 10 deg. 23 min. for the *Declination* at 7 the next Morning.

[illegible] 7

[illegible] Licen[illegible]

T[illegible] for the [illegible] at Plan[illegible]

[illegible] to any [illegible] Canadian [illegible]

[illegible] the Day and M[illegible]

[illegible] Minutes and [illegible]

[illegible] Days [illegible]

[illegible] Hours and [illegible] Two [illegible]

[illegible] Night [illegible] Minutes [illegible]

[illegible] hours of Night [illegible]

[illegible] Twelve and [illegible] Eleven [illegible]

[illegible] begin [illegible] next [illegible]

[illegible] the Day [illegible]

THE
Astral Kalendar.

Containing all the

FIXED STARS

OF THE

FIRST, SECOND, and THIRD,

MAGNITUDES.

THEIR

Longitudes corrected, and reduced from the Pole of the *Ecliptick* to the Pole of the *World*; That is to say, Brought into Right Ascensions and Declinations.

To which are added,

Their Right Ascensions in Time, and Semidiurnal Arks; whereby their Rising, Southing, and Setting may (at at time) be easily obtained: Also upon what Day of the Year each of them will be upon the *Meridian* at Midnight, and consequently the Stars known one from another.

The Northern

STARS NAMES.	*Upon the Meridian at Midnight.*
Ursa Minor. Cynosura.	
In the Extremity of the Tail, or *Pole-Star*	*Decemb.* 5
The Upper of the Two preceding in the Square	*Januar.* 17
The Lower of the same	24
Ursa Major. Helice.	
In the former Left Knee	*Januar.* 11
The Northerly of the two in the Right Foot	7
The Southerly	8
The Upper of the foregoing in the greater Square	19
The Lower of the same Square	23
The Upper of the following in the Square	*February* 4
The Lower of the same	4
The last save Two of the Tail	12
The last save one	18
The last of the Tail	*March* 2
That between this *Bear's* Tail and the *Lion*	*Februar.* 26
That between the Fore-foot of the *Bear* and the First of the *Lion's Head*	*Januar.* 16
The following Southern	30
The foregoing of the Two in the Base of the *Oxigon*	*February* 2
The following one	5
Draco.	
The foregoing of the Two Bright ones in the Head	*May* 18
The Bright one in the Head	*June* 4
The Northern of the Square in the second Bending	*Septem.* 26
The Southern of the same Side	*October* 11
That in the Flexure (or Bending) of the third Joint	*February* 8
The meanly Bright one near the *Pole*	*March* 8
The last but Two foregoing the Flexure	23
The last but one to the Flexure	10
That which next follows the Flexure	*Februar.* 11
The last but one of the Tail	*Januar,* 20
The last of the Tail	15
Cepheus.	
In the Girdle	*October* 14
The Bright one in the Right Shoulder	*Septem.* 21
In the Left Foot	*Novemb.* 7
Bootes. Artophylax.	
In the Left Shoulder	*March* 24
In the Head	30
In the Right Shoulder, above the Crown	*April* 8
In the Hip, below the Right Arm	3
That in the Right Leg	8
The Upper one of the Leg	*March* 24
In the Skirt. *Arcturus*	30

Corona

Constellations.

Magnitude	Longitude.			Latitude.		Right Ascension.		Declination.		Right Ascension in Time.		Semidiurnal Ark.	
	Sin.	Deg.	Min.	Deg.	Min.	Deg.	Min.	Deg.	Min.	Ho.	Min.	Ho.	M.
						The Lesser Bear.							
2	♊	24	2	66	2	7	53	87	33	0	31	Sets not.	
2	♌	8	16	72	51	42	46	75	36	2	51	Sets not.	
3	♌	15	41	75	23	51	14	73	15	3	25	Sets not.	
						The Greater Bear.							
3	♌	1	32	34	34	135	56	53	10	9	3	Sets not.	
3	♋	26	56	29	15	127	20	49	20	8	29	Sets not.	
3	♋	28	10	28	38	128	34	48	21	8	34	Sets not.	
2	♌	10	34	49	40	160	48	63	32	10	43	Sets not.	
2	♌	14	43	45	3	160	18	58	8	10	41	Sets not.	
2	♌	26	25	51	37	179	48	58	51	11	59	Sets not.	
2	♌	25	45	47	16	173	59	55	33	11	56	Sets not.	
2	♍	4	10	54	18	9	53	57	47	0	39	Sets not.	
2	♍	10	56	56	22	17	37	56	41	1	30	Sets not.	
2	♍	22	12	54	25	23	37	51	00	1	34	Sets not.	
2	♍	18	43	40	6	9	4	40	34	0	36	Sets not.	
3	♌	7	17	17	55	135	15	35	45	9	1	10	16
3	♌	20	57	24	50	153	8	37	49	10	12	11	16
3	♌	24	22	21	28	155	6	33	30	10	20	9	46
3	♌	27	9	20	44	157	36	31	48	10	30	9	30
						The Dragon.							
3	♐	7	19	75	21	80	46	52	34	5	23	Sets not.	
3	♐	23	24	75	3	87	15	51	36	5	49	Sets not.	
3	♈	13	26	82	49	108	14	67	7	7	13	Sets not.	
3	♈	28	47	79	25	117	27	69	30	7	49	Sets not.	
3	♍	0	44	81	4	167	22	69	24	4	29	Sets not.	
3	♍	27	51	84	46	256	59	66	8	5	7	Sets not.	
3	♎	13	28	74	11	239	4	58	58	3	56	Sets not.	
3	♎	0	22	71	4	229	27	60	3	3	18	Sets not.	
2	♍	3	10	66	36	209	40	65	56	1	59	Sets not.	
3	♌	11	26	61	33	184	13	71	34	0	17	Sets not.	
3	♌	5	37	57	7	167	15	71	5	11	9	Sets not.	
						Cepheus.							
3	♉	1	13	71	7	321	3	69	9	9	24	Sets not.	
3	♈	8	13	68	54	317	38	61	10	9	10	Sets not.	
3	♉	25	23	64	28	351	59	75	41	11	27	Sets not.	
						The Bear-keeper, or Bear-ward.							
3	♎	14	5	49	33	215	29	39	24	2	22	Sets not.	
3	♎	19	43	54	15	222	32	41	44	2	50	Sets not.	
3	♎	28	29	49	1	225	34	34	34	3	2	8	1
3	♎	23	29	40	40	217	40	28	29	2	31	8	53
3	♎	28	26	27	57	216	24	15	11	2	26	7	19
3	♎	14	42	28	9	204	45	20	5	1	39	7	48
1	♎	19	39	31	2	210	13	20	58	2	1	7	55

The

STARS NAMES.	Upon the Meridian at Midnight.	
Corona Borea.		
The Bright one of the Crown	April	17
Engonasi Hercules.		
In the Head	May	22
In the Right Shoulder		7
The last save one of the Right Arm		5
In the Left Shoulder		21
That in the Left Hip		8
The more Easterly than this in the Left Thigh		15
In the Left Knee	June	4
That in the Left Leg Calf, nigh the *Dragon's Head*	May	27
In the Upper Right Thigh		5
Lyra, Vultur cadens.		
The Bright one of the Harp	June	22
The Northern of the two foremost in the Neck		26
The Northern of the two following in the Neck		29
Olor. Cygnus.		
In the Bill	July	9
In the Breast	August	2
In the Tail	Novemb.	3
The First and Brightest in the Pinnion of the Upper Wing	July	25
That in the Pinnion of the Lower Wing	August	6
The uttermost of the Lower Wing		11
Below the Wing, towards *Pegasus* Foot		18
Cassiopeia.		
In the Breast. *Schedir*	October	16
In the Flexure (or Bending) at the Hips		22
In the Leg		26
At the Knee	Novemb.	2
The Bright one of the Chair	October	13
Perseus.		
In the Right Shoulder	Novemb.	7
The very Bright one in the Right Side		9
That at the Flexure of the same Side		2
The Head of *Medusa*. *Algol*		3
That in the Left Knee		13
The following one of the Left Foot		10
Auriga, Heniochus, Ericthonius.		
The Bright one in the Left Shoulder. *Capella*	Novem.	28
The Bright one in the Right Shoulder	Decemb.	7
Ophyuchus, Serpentarius.		
In the Head	May	29
In the Right Shoulder	June	1
The Lower and Follower in the Right Shoulder		3

The

Magnitude	Longitude Sin	Longitude Deg.	Longitude Min.	Latitude Deg.	Latitude Min.	Right Ascension Deg.	Right Ascension Min.	Declination Deg.	Declination Min.	Right Ascension in Time Ho.	Right Ascension in Time Min.	Simidiurnal Ark Ho.	Simidiurnal Ark M.
						The Northern Crown.							
2	♏	7	38	44	23	230	12	27	51	3	21	Sets not.	
						Engonasi Hercules.							
3	♐	11	31	37	23	254	12	14	50	4	57	7	18
3	♏	26	27	42	48	245	12	22	16	4	21	8	4
3	♏	24	36	40	5	241	52	19	59	4	7	7	47
3	♐	10	10	47	47	255	24	25	16	5	2	8	26
3	♏	27	2	53	10	247	19	32	14	5	29	8	4
3	♐	3	45	53	21	251	58	31	28	4	47	10	56
3	♐	23	56	60	47	266	17	37	21	5	41	Sets not.	
3	♐	15	17	66	22	262	34	46	14	5	30	Sets not.	
3	♏	24	8	60	22	247	56	39	35	4	31		
						The Harp: Or, Falling Vultur.							
1	♑	10	43	61	47	276	27	38	30	6	26	Sets not.	
3	♑	14	16	56	5	279	27	33	2	6	38	9	39
3	♑	17	11	55	6	281	32	32	16	6	46	9	31
						The Swan.							
3	♑	26	44	49	2	289	23	27	18	7	18	8	43
3	♒	20	25	57	9	302	39	39	13	8	10	Sets not.	
2	♏	20	53	59	56	307	32	44	5	8	30	Sets not.	
3	♒	11	53	64	28	393	44	44	22	7	35	Sets not.	
3	♒	23	9	49	26	308	14	32	45	8	33	9	36
3	♒	28	43	43	44	314	54	28	57	8	59	8	57
3	♓	5	33	38	39	322	20	26	20	9	29	8	35
						Cassiope.							
3	♉	3	17	46	35	5	32	54	45	0	22	Sets not.	
3	♉	9	27	48	46	9	22	58	57	0	38	Sets not.	
3	♉	13	21	46	22	16	10	58	30	1	5	Sets not.	
3	♉	20	13	47	29	22	51	62	1	1	31	Sets not.	
3	♉	0	35	51	14	357	59	57	22	11	51	Sets not.	
						Perseus.							
3	♉	25	26	34	30	40	17	52	12	2	41	Sets not.	
2	♉	27	17	30	5	44	16	48	36	2	57	Sets not.	
3	♉	20	15	27	14	38	0	43	49	2	32	Sets not.	
3	♉	21	37	22	22	41	46	39	39	2	47	Sets not.	
3	♊	1	8	19	4	54	1	39	2	3	36	Sets not.	
3	♉	28	36	11	17	53	27	30	54	2	3	9	15
						The Carter, Wagoner, or Wain-man.							
1	♊	77	16	22	50	73	7	45	37	4	52	Sets not.	
2	♊	26	52	21	27	85	53	44	56	5	43	Sets not.	
						The Serpent Bearer.							
3	♐	17	50	35	57	259	55	12	52	5	19	7	7
3	♐	20	45	28	1	261	49	4	46	5	27	6	20
3	♐	22	5	26	11	262	53	2	51	5	31	6	9

STARS NAMES.	Upon the Meridian at Midnight.	
The more Northern in the Left Hand	*May*	9
The more Southern following		10
In the Right Knee	*May*	25
In the Left Knee		15
That in the Right Shin		26
The foremost of the Four in the Right Foot.		26

Serpens Ophiuchi.

That in the Mouth	*April*	25
That in the Temples, or Side of the Head		28
In the stretching out of the Neck		25
The Second in the Neck, below the Head		24
In the Middle of the Knot in the Neck		27
The last save two of the Tail	*June*	6
The last save one		12
The last		23

Sagitta, sive Telum.

There is no Eminent Star

Aquila, seu Vultar volans.

In the Neck	*July*	11
The Bright one in the Shoulder-blade		10
That in the Left Shoulder		8
The Tail of the *Vultur*	*June*	27
That which next precedes the Tail		25

Antinous.

In the Left Hand	*July*	13
In the Right Side		3
In the Knee		2
In the Right Arm		1
In the Breast		7
In the Right Foot	*June*	24

Delphinus.

The Bright one of the Tail	*July*	22
The more Southerly of the foremost of the *Rhomboid*		24
The more Northerly of the same Side		25
The more Southerly of the following Side		27
That in the Head.		28

Equuseus, Equisectio.

No Eminent Star

Pegasus, Equus Alatus.

The Mouth of *Pegasus*	*July*	27
The Bright one of the Neck	*Aug.*	24
The Right Knee	*Sept.*	4
The First of the Wing *Marchab*	*Aug.*	31
The Drawing forth of the Leg *Scheat*	*Sept.*	8
The Uttermost of the Wing.		17

Magnitude	Longitude. Sin	Deg.	Min.	Latitude. Deg.	Min.	Right Ascension. Deg.	Min.	Declination. Deg.	Min.	Right Ascension in Time. Ho.	Min.	Simidiurnal Ark. Ho.	M.
3	♏	27	44	17	19	239	19	2	49 S.	3	57	5	41
3	♏	28	57	16	30	240	17	3	51 S.	4	1	5	36
3	♐	13	24	7	18	252	55	15	14 S.	4	51	4	36
3	♐	4	39	11	30	244	48	9	49 S.	4	19	5	3
3	♐	15	23	2	12	254	23	20	31 S.	4	58	4	7
3	♐	15	1	2	16	254	0	20	25 S.	4	56	4	7

The Serpent of Ophiucus.

3	♏	15	24	39	6	234	19	20	58	3	37	7	55
3	♏	18	6	35	25	235	21	16	49	3	41	7	30
3	♏	15	21	34	27	232	49	16	32	3	31	7	28
3	♏	13	46	28	58	229	50	11	41	3	19	7	0
2	♏	17	30	25	35	232	4	7	30	3	28	6	32
3	♐	25	34	19	57	265	50	3	30 S.	5	43	5	27
3	♍	1	12	20	37	271	8	2	53 S.	6	4	5	41
3	♑	11	10	26	59	279	7	3	51	6	39	6	10

The Arrow, or Dart.

in this Constellation.

The Eagle, or Flying Vultur.

3	♑	27	53	26	49	294	48	5	41	7	39	6	24
2	♑	27	9	29	21	293	41	8	3	7	35	6	35
3	♑	26	26	31	18	292	43	9	54	7	31	6	48
3	♑	15	15	36	16	282	36	13	25	6	50	7	8
3	♑	13	44	37	40	281	12	14	41	6	45	7	16

Antinous.

3	♒	0	21	18	48	298	36	1	45 S	7	54	5	52
3	♑	21	17	20	14	289	56	1	47 S	7	19	5	52
3	♑	20	17	14	28	289	48	7	40 S	7	19	5	21
3	♑	19	1	24	56	287	12	2	33	7	9	6	8
3	♑	25	50	21	88	293	54	0	14	7	35	6	1
3	♑	12	46	17	41	282	12	5	17 S	6	49	5	26

The Dolphin.

3	♒	9	32	29	8	304	24	10	14	8	18	6	49
3	♒	11	56	31	57	305	40	13	30	8	23	7	8
3	♒	12	50	33	5	306	6	14	48	8	24	7	17
3	♒	14	36	32	0	307	54	14	11	8	31	7	13
3	♒	14	52	32	41	307	53	15	00	8	31	7	17

The Horse-Colt, or Little Horse.

in this Constellation.

Pegasus. The Winged Horse.

3	♒	27	22	22	7	322	3	8	24	9	28	6	31
3	♓	11	39	17	41	336	21	9	8	10	25	6	43
3	♓	21	10	35	7	336	54	28	31	10	27	8	53
2	♓	18	56	19	26	342	7	13	28	10	48	7	8
2	♓	24	49	31	7	341	59	26	18	10	48	8	35
2	♈	4	38	12	35	359	8	13	22	11	56	7	8

STARS NAMES.	Upon the Meridian at Midnight.	
Andromeda.		
The Head	*Septem.*	22
The more Southern in the Girdle	*October*	9
The Bright one in the Southern Foot		22
The Clearer and Upper in the Left Shoulder	*Sept.*	30
Triangulus, Deltoton.		
	No Eminent Star	
Coma Berenices.		
In the top of the First and Northern Triangle	*June*	10

The 12 Zodiacal

ARIES.		
The Bright one in the top of the Head	*October*	16
The Eastern in the Base of the Triangle		26
TAURUS.		
In the Face, the First of the *Suculæ*, in the Nostrils.	*Novem.*	13
Between this and the Northern Eye.		14
In the Southern Eye. *ALDEBARON. Palilicium.*		17
In the Northern Eye.		16
In the extremity of the South Horn	*Decemb.*	1
In the extremity, common with the Right Foot of *Heniochus*	*Novem.*	30
The Midddle and Bright one of the Seven Stars		7
GEMINI.		
In the upper Head, *Castor. APOLLO.*	*Decemb.*	26
In the lower Head. *Pollux. HERCULES.*		29
In the Northern and upper Knee		16
In the Left Knee		21
That in the Belly of the Southern Twin		24
That in the Foot, called the Heel		11
The Bright one of the Foot.		15
CANCER.		
In the Southern Claw	*Januar.*	18
LEO.		
The more Southerly in the Head	*Jan.*	25
The three Northern in the Neck	*Feb.*	1
The Middle and Bright one in the Neck		2
The Southern one		1
The Lyons Heart. *Regulus, Basiliscus*		3
The Bright one that follows		14

Magnitude	Longitude. Sin.	Deg.	Min.	Latitude. Deg.	Min.	Right Ascension. Deg.	Min.	Declination. Deg.	Min.	Right Ascension in Time. Ho.	Min.	Semidiurnal Ark. Ho.	M.
						Andromeda.							
2	♈	9	47	25	42	357	54	27	18	11	51	8	23
2	♈	25	49	25	59	12	49	33	55	0	51	9	52
2	♉	9	39	27	46	25	57	40	44	1	43	Sets not.	
3	♈	17	19	24	20	5	33	29	5	0	22	8	58

The Triangle.

in this Constellation.

Berenice's Hair.

3	♐	29	17	28	25	182	39	30	6	0	10	9	8

Constellations.

The Ram.

3	♉	3	6	9	57	27	12	21	54	1	59	8	4
3	♉	13	40	10	24	34	44	25	53	2	19	8	31

The Bull.

3	♊	1	12	5	46 S	60	17	14	59	4	1	7	17
3	♊	2	16	4	2 S	61	1	16	44	4	4	7	29
1	♊	5	12	5	31 S	64	17	15	48	4	17	7	22
3	♊	3	53	2	36 S	62	23	18	26	4	10	7	39
3	♊	20	12	2	14 S	79	30	20	56	5	18	7	55
2	♊	17	59	5	0	76	23	28	21	5	5	8	51
3	♉	25	24	4	0	52	00	23	3	3	28	8	10

The Twins.

2	♋	15	41	10	2	108	24	32	33	7	14	9	34
2	♋	18	43	6	38	111	19	28	46	7	25	8	35
3	♋	5	22	2	11	95	57	25	35	6	23	8	29
3	♋	10	26	2	6 S	101	11	21	00	6	44	7	56
3	♋	13	56	0	13 S	105	7	22	34	7	0	8	8
3	♋	0	44	0	53 S	88	48	22	38	5	55	8	8
2	♋	4	31	6	48 S	94	1	16	38	6	19	7	28

The Crab.

3	♌	9	3	5	8 S	130	7	16	6	8	40	7	24

The Lion.

3	♌	16	5	9	40	141	44	25	16	9	27	8	26
3	♌	22	57	11	50	149	34	25	2	9	58	8	24
2	♌	24	59	8	47	150	26	21	29	10	2	7	59
3	♌	23	20	4	52	147	22	18	22	9	50	7	39
1	♌	25	17	0	26	147	43	13	33	9	51	7	7
2	♍	6	41	14	20	164	8	22	20	10	56	8	7

STARS NAMES.	*Upon the Meridian at Midnight.*	
The Foremoſt and Northern of the two in the Buttock	*Feb.*	17
In the Thigh		21
The Bright one in the End or Tip of the Tail.		25
VIRGO.		
In the Tip of the Southern and Left Wing.	*March*	2
In the Right Side, under the Girdle	♎	6
The more Northerly, called *Vindemiatrix*		15
In the Left-Hand, called the *Virgins Spike*		30
Under the —— in the Right Buttock.		26
LIBRA.		
The Southern Balance	*April*	20
The Northern Balance		24
The Third from the ſame Balance to the Eaſt		30
Under the Northern Balance, in the Left Claw of the *Scorpion*		26
That which follows.		26
SCORPIO.		
The Uppermoſt in the Forehead	*May*	9
The Middle one in the Forehead		9
The Southern of the Three Bright ones in the Forehead		19
The Red ſhining one in the Middle, *Antares, Scorpio's Heart*		16
SAGITTARIUS.		
In the Point of the Arrow or Shaft	*June*	7
In the Haft or Handle in the Left Hand		7
CAPRICORNUS.		
The Northern of the Three in the former Horn	*July*	12
The Southern one		12
The foregoing of the Two Bright ones in the Tail	*July*	30
That which follows	*Aug.*	1
AQUARIUS.		
The Brighter in the Right Shoulder	*Aug.*	4
In the Left Shoulder	*July*	30
In the Elbow of the Right Arm	*Aug.*	15
The Southern one in the Right-Leg Calf, *Scheat*		17
The laſt in the Water-pouring, *Fomahant.*	*Aug.*	12
PISCES.		
The Bright one in the Faſtning of the *Purſnets.*	*Oct.*	7

The

Magnitude	Longitude. Sin.	Deg.	Min.	Latitude. Deg.	Min.	Right Ascension. Deg.	Min.	Declination. Deg.	Min.	Right Ascension in Time. Ho.	Min.	Semidiurnal Ark. Ho.	M.
3	♍	8	50	9	41	164	15	17	14	10	1	7	33
3	♍	12	58	6	7	166	43	12	21	11	7	7	3
2	♍	17	3	12	18	173	4	16	25	11	32	7	27
					The Virgin.								
3	♍	22	32	0	43	273	26	3	38	6	14	6	12
3	♎	6	55	8	41	189	48	5	13	0	39	6	21
3	♎	5	23	16	15	191	30	12	45	0	46	7	5
1	♎	19	16	1	59 S	196	56	9	31 S	1	7	5	3
3	♎	16	22	8	10	198	13	1	5	1	13	6	2
					The Ballance.								
2	♏	10	31	0	26	218	13	14	37 S	2	33	4	41
2	♏	14	48	8	35	224	52	8	7 S	2	59	5	9
3	♏	20	33	4	28	229	19	13	38 S	3	17	4	43
3	♏	16	27	7	37 S	221	35	24	5 S	2	46	3	43
3	♏	16	17	1	48 S	223	15	18	29 S	2	53	4	17
					The Scorpion.								
2	♏	28	36	1	5	236	36	18	51 S	3	46	4	16
3	♏	27	59	1	54 S	235	15	21	38 S	3	41	4	2
3	♏	28	25	5	22 S	234	50	25	6 S	3	39	3	36
1	♐	5	13	4	27 S	242	23	25	37 S	4	9	3	31
					The Archer, or Bow-man.								
3	♐	26	30	6	54 S	265	58	30	22 S	5	43	2	49
3	♐	26	51	6	50 S	269	50	30	21 S	5	59	2	49
					Capricorn.								
3	♑	29	18	7	2	299	58	13	29 S	7	59	4	44
3	♑	29	31	4	41	300	40	15	44 S	8	3	4	34
3	♒	17	14	2	26 S	320	29	18	2 S	9	22	4	21
3	♒	19	00	2	29 S	322	15	17	32 S	9	29	4	24
					The Water-keeper.								
3	♒	28	49	10	42	337	16	1	52 S	9	49	5	46
3	♒	18	51	8	42	318	7	6	56 S	9	12	5	16
3	♓	2	10	8	17	332	30	2	59 S	10	10	5	41
3	♓	4	22	8	10 S	339	22	17	31 S	10	38	4	24
1	♒	29	11	21	00 S	339	46	31	17 S	10	39	2	40
					The Fishes.								
3	♈	24	47	9	4 S	26	16	1	11	1	45	6	3

The Southern

STARS NAMES.	Upon the Meridian at Midnight.
Cete.	
The Bright one of the *Whale's* Jaw	October 23
The Middle one in the Mouth	18
The foremost of the Three at the Cheek	15
The Northern one of the Belly	Septem. 30
The more Easterly of the two Bright ones in the Back	24
The more Westerly of the same	20
The Northern one of the Tail	9
The Southern and Brighter of the Tail	11
Orion.	
The following, or Bright one in the Right Shoulder	Decemb. 5
The Left, or foremost	Novem. 28
The First of the Belt	30
The Middle one	Decemb. 1
The Last	2
In the Hilt or Handle of the Sword	Novem. 27
The middle one of the Sword	29
The Southern one	30
The Bright one in the Left Foot. *Regel*	23
In the Right Knee	Decemb. 3
Eridanus.	
Above the Foot of *Orion*, in the River	Novem. 22
The First of those which touch the *Whale*	October 17
The Third that follows	22
Lepus.	
That in the Back or Middle of the Body	Novem. 28
In the Left Shoulder	27
The more Southerly of the two in the hinder Feet	Decemb. 2
The more Northerly of them	4
Canis Major.	
The Bright shining one in the Mouth. *Sirius*	Decemb. 20
That under the Left Ear	Januar. 24
That in the End or Top of the Fore-foot	12
That in the Belly	27
The foremost of the Right Foot	Decemb. 13
That in the Tail	January 5
Canis Minor. Procyon.	
In the Neck	Decemb. 28
In the Thigh. *Procyon*	January 1

Conſtellations.

Magnitude	Longitude. Sin	Deg.	Min.	Latitude. Deg.	Min.	Right Aſcenſion. Deg.	Min.	Declination. Deg.	Min.	Right Aſcenſion in Time. Ho.	Min.	Simidiurnal Ark. Ho.	M.
						The Whale.							
2	♉	9	47	12	37 S	41	21	2	48	2	45	6	9
3	♉	4	53	12	2 S	36	37	1	50	2	26	6	5
3	♉	3	2	14	32 S	35	44	1	7 S	2	23	5	49
3	♈	17	25	20	19 S	23	52	11	54 S	1	35	4	51
3	♈	11	42	15	46 S	16	58	9	52 S	1	7	5	3
3	♈	7	11	16	55 S	13	23	12	39 S	0	55	4	48
3	♓	26	23	10	1 S	0	43	10	37 S	0	3	4	58
2	♓	27	56	20	47 S	6	45	19	48 S	0	27	4	11
						Orion.							
2	♊	24	12	16	6 S	84	23	7	18	5	38	6	31
2	♊	16	23	16	53 S	76	54	6	1	5	7	6	24.
2	♊	17	50	23	38 S	78	52	0	35 S	5	15	5	55
2	♊	18	54	24	33 S	79	55	1	26 S	5	19	5	49
2	♊	20	6	25	21 S	81	4	2	9 S	5	24	5	44
3	♊	15	37	25	36 S.	77	3	2	44 S.	5	8	5	42
3	♊	18	24	28	45 S.	79	48	5	39 S.	5	16	5	42
3	♊	18	27	29	17 S.	79	52	6	10 S.	5	19	5	20
1	♊	12	17	31	11 S.	74	44	8	37 S.	4	59	5	6
3	♊	21	49	33	8 S.	83	3	9	49 S.	5	32	5	3
						The River.							
3	♊	10	40	27	54 S.	72	56	5	32 S.	4	51	5	23
3	♉	4	00	24	34 S.	40	8	11	1 S.	2	40	4	56
3	♉	9	16	25	59 S.	45	11	10	4 S.	3	0	5	2
						The Hare.							
3	♊	16	49	41	5 S.	79	35	18	03 S.	5	18	4	21
3	♊	15	6	43	57 S.	78	35	21	2 S.	5	14	4	4
3	♊	20	21	45	49 S.	82	32	22	33 S.	5	30	3	56
3	♊	22	36	44	18 S.	48	20	20	56 S.	3	13	4	5
						The Great Dog.							
1	♋	9	35	39	30 S.	97	42	16	14 S.	6	31	4	34
3	♋	15	6	38	2 S.	102	16	15	10 S.	6	49	4	40
2	♋	2	42	41	18 S.	92	8	17	49 S.	6	8	4	25
3	♋	18	55	48	30 S.	103	48	25	53 S.	6	55	3	29
3	♋	2	7	51	46 S.	91	29	28	16 S.	6	6	3	9
3	♋	25	11	51	24 S.	107	45	29	26 S.	7	11	2	59
						The Lesser Dog.							
2	♋	17	39	13	33 S.	107	22	8	54	7	9	6	42
2	♋	21	18	15	57 S.	110	34	6	03	7	22	6	25

STARS NAMES.	*Upon the Meridian at Midnight.*
Argo. Navis.	
That in the uppermoſt Part of the Caſtle	*Januar.* 16
The Uppermoſt of the	11
The former of	9
The following one	*Februar.* 13
That between the Sail and the Milke Way	*March* 5
Hydra.	
The Bright one of *Hydra*, or the Heart	*Januar.* 31
Under the Tail of the *Raven*	*April* 2
That before *Hydra*'s Head	*January* 9
Crater.	
	No Eminent Star
Corvus.	
The former of the two Upper ones in the Square	*March* 16
The following one hf the ſame Square	18
The following one of the Lower in the Square	22
Centaurus. Chiron.	
	No Eminent Star

Finis Catalogus.

Magnitude	Longitude. Sin.	Deg.	Min.	Latitude. Deg.	Min.	Right Ascension. Deg.	Min.	Declination. Deg.	Min.	Right Ascension in Time. Ho.	Min.	Simidiurnal Ark. Ho.	Min
						The Ship, Argo.							
3	♌	6	53	43	18 S.	118	25	14	48 S.	7	54	4	42
3	♌	1	35	44	58 S.	113	57	12	22 S.	7	35	4	55
3	♋	29	0	47	28 S.	111	24	6	6 S.	7	26	5	30
3	♍	5	20	22	29 S.	148	55	11	22 S.	9	55	5	1
3	♍	24	44	30	30 S.	162	14	25	43 S.	10	49	3	30
						The Water Serpent.							
1	♌	22	45	22	24 S.	137	54	7	15 S.	9	11	5	22
3	♎	22	24	13	43 S.	195	15	21	25 S.	1	1	4	1
3	♋	29	44	10	19 S.	119	43	10	11 S.	7	59	6	53

The Cup.

in this Constellation.

						The Raven.							
3	♎	6	13	14	25 S.	179	49	15	39 S.	11	35	4	35
3	♎	8	55	12	7 S.	183	16	14	39 S.	0	13	4	39
3	♎	12	49	17	59 S.	184	20	21	33 S.	0	17	4	0

The Centaure.

in this Constellation.

The End of the Catalogue.

A TABLE *of the Sun's* Right Ascension *in every Degree of the* Ecliptick, *to be used with the foregoing* Table *of* Fixed Stars.

	♈ *Aries.*		♉ *Taurus.*		♊ *Gemini.*		♋ *Cancer.*		♌ *Leo.*		♍ *Virgo.*		♎ *Libra.*		♏ *Scorp.*		♐ *Sagit.*		♑ *Capric.*		♒ *Aquar.*		♓ *Pisces.*	
	D.	M.	D.	M	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M	D.	M.	D.	M.	D.	M	D.	M.
0	0	0	27	54	57	48	90	0	122	12	152	6	180	0	207	54	237	48	270	0	302	12	332	6
1	0	55	28	51	58	51	91	5	123	14	153	2	180	55	208	51	238	51	271	5	303	14	333	3
2	1	50	29	49	59	53	92	11	124	16	154	1	181	50	209	49	239	53	272	11	304	16	334	1
3	2	45	30	46	60	56	93	16	125	19	154	58	182	45	210	46	240	56	273	16	305	19	334	58
4	3	40	31	43	61	59	94	22	126	20	155	54	183	40	211	44	241	59	274	22	305	20	335	54
5	4	35	32	42	63	2	95	27	127	22	156	51	184	35	212	42	243	3	275	27	307	22	336	51
6	5	39	33	40	64	9	96	32	128	24	157	48	185	30	213	40	244	6	276	32	308	24	337	48
7	6	25	34	38	65	6	97	38	129	25	158	44	186	25	214	39	245	9	277	38	309	25	338	44
8	7	21	35	37	66	13	98	43	130	26	159	40	187	21	215	37	246	13	278	43	310	26	339	40
9	8	16	36	36	67	17	99	48	131	27	160	37	188	16	216	36	247	17	279	48	311	27	340	37
10	9	11	37	34	68	21	100	53	132	28	161	33	189	11	217	34	248	21	280	53	312	28	341	33
11	10	6	38	33	69	25	101	58	133	28	162	29	190	6	218	33	249	25	281	58	313	29	342	29
12	11	1	39	33	70	29	103	3	134	29	163	25	191	2	219	32	250	29	283	3	314	29	343	25
13	11	57	40	32	71	34	104	8	135	29	164	20	191	57	220	31	251	34	284	8	315	29	344	20
14	12	52	41	31	72	38	105	13	136	29	165	16	192	53	221	31	252	38	285	13	316	29	345	16
15	13	48	42	31	73	43	106	17	137	29	166	12	193	48	222	31	253	43	286	17	317	29	346	12
16	14	44	43	31	74	47	107	22	138	29	167	7	194	44	223	31	254	47	287	22	318	29	347	7
17	15	40	44	31	75	52	108	26	139	28	168	3	195	40	224	31	255	52	278	25	319	28	348	3
18	16	35	45	31	76	57	109	3	140	27	168	58	196	35	225	31	256	57	289	31	320	27	348	58
19	17	31	46	32	78	1	110	35	141	27	169	54	197	31	226	32	258	2	290	35	321	27	349	54
20	18	27	47	32	79	7	111	39	142	26	170	49	198	27	227	32	259	7	291	39	322	26	350	49
21	19	23	48	33	80	12	112	43	143	24	171	44	199	23	228	33	260	12	292	43	323	24	351	44
22	20	20	49	34	81	17	113	47	144	23	172	39	200	20	229	34	261	17	293	47	324	23	552	39
23	21	16	50	35	82	22	114	51	145	22	173	35	201	16	230	35	262	22	294	51	325	22	353	35
24	22	12	51	36	83	28	115	54	146	20	174	30	202	12	231	36	263	28	295	54	326	20	354	30
25	23	9	52	38	84	32	116	57	147	18	175	25	203	9	232	38	264	33	296	57	327	18	355	25
26	24	6	53	48	85	38	118	1	148	16	176	20	204	6	233	40	265	38	298	1	328	16	356	20
27	25	2	54	42	86	44	119	4	149	14	177	15	205	2	234	41	266	44	299	4	329	15	357	15
28	25	59	55	44	87	49	120	7	150	11	178	10	205	59	235	44	267	49	300	7	330	11	358	10
29	26	56	56	46	88	55	121	9	151	9	179	5	206	56	236	46	268	55	301	9	331	9	359	5
30	27	54	57	48	50	0	122	12	152	6	180	1	207	54	237	48	270	0	302	12	332	6	360	0

The Use of this Table.

Having found in what Sign and Degree of that Sign the Sun is on any Day; which you may find in the Third Column of the *DIARY*, against every Day in the Year: seek the Sign in the Head, or top of this *Table*, and the Degree of the Sign in the First Column hereof, and in the common *Angle* you shall have the Sun's *Right Ascension* for that Day.

Example. Let the Sun's *Right Ascension* be required upon the fifth of *August*.

Look in the *DIARY* for the Fifth of *August*, and against it you shall find 22 deg. 49 min. of *Leo*; and that is the Sign, Degree, and Minute in which the Sun is on the Fifth of *August* at Noon.

Now to find his *Right Ascension* for that time, look for *Leo* in the Head of this *Table*, and for 23 deg. in the First Column on the Left-hand, (because 22 deg. 49 min. is nearer to 23 deg. then to 22 deg.) and under *Leo*, and against 23 in the First Column, you shall find 145 deg. 22 min. for the Sun's *Right Ascension* on the Fifth of *August*.

In like manner,

			D.	M.			D.	M.
On the	10 of *January*	the Sun is in	1	6 ♒	and his *Right Ascension*		303	14
	6 of *April*		26	59 ♈			25	02
	16 of *Decemb.*		5	20 ♑			275	27

And so for any other Day in the Year.

A TA-

A TABLE readily shewing how to Reduce Degrees and Minutes of the Æquinoctial *into Degrees and Minutes of* Time : *And Hours, Minutes, and Seconds of* Time, *into Degrees and Minutes of the* Æquinoctial.

Degrees of the Æquinoctial.

Hours.															
O	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
I	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
II	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
III	45	46	47	49	49	50	51	52	53	54	55	56	57	58	59
IV	60	61	62	64	64	65	66	67	68	69	70	71	72	73	74
V	75	76	77	79	79	80	81	82	83	84	85	86	87	88	89
Minutes of the Æquinoctial.	M. Se.	M. Se.	M. Se.	M. Se.	M. Se.	M. Se.	M. Se.	M. Se.	M. Se.	M. Se.	M. Se.	M. Se.	M. Se.	M. Se.	M. Se.
0	0 0	4 0	8 0	12 0	16 0	20 0	24 0	28 0	32 0	36 0	40 0	44 0	48 0	52 0	56 0
5	0 20	4 20	8 20	12 20	16 20	20 20	24 20	28 20	32 20	36 20	40 20	44 20	48 20	52 20	56 20
10	0 40	4 40	8 40	12 40	16 40	20 40	24 40	28 40	52 40	36 40	40 40	44 40	48 40	52 40	56 40
15	1 0	5 0	9 0	13 0	17 0	21 0	25 0	29 0	33 0	37 0	41 0	45 0	49 0	53 0	57 0
20	1 20	5 20	9 20	13 20	17 20	21 20	25 20	29 20	33 20	37 20	41 20	45 20	49 20	53 20	57 20
25	1 40	5 40	9 40	13 40	17 40	21 40	25 40	29 40	33 40	37 40	41 40	45 40	49 49	53 40	57 40
30	2 0	6 0	10 0	14 0	18 0	22 0	26 0	30 0	34 0	38 0	42 0	46 0	50 0	54 0	58 0
35	2 20	6 20	10 20	14 20	18 20	22 20	26 20	30 20	34 20	38 20	42 20	46 20	50 20	54 20	58 20
40	2 40	6 40	10 40	14 40	18 40	22 40	26 40	30 40	34 40	38 40	42 40	46 40	50 40	54 40	58 40
45	3 0	7 0	11 0	15 0	19 0	23 0	27 0	31 0	35 0	39 0	43 0	47 0	51 0	55 0	59 0
50	3 20	7 20	11 20	15 20	19 20	23 20	27 20	31 20	35 20	39 20	43 20	47 20	51 20	55 20	59 20
55	3 40	7 40	11 40	15 40	19 40	23 40	27 40	31 40	35 40	39 40	43 40	47 40	51 40	55 40	59 40

Minutes and Seconds of Time.

The Description and Use of the Table of REDUCTION.

The Description.

IN the Six uppermost Lines of the Table are all the Degrees of the *Equinoctial*, from 0 deg. to 90 deg. each Line containing 15 deg. thereof, or one Hour of Time, as is noted in the first Column towards the Left-hand, at the end of each Line.

In the under Part of the Table, and in the first Column thereof towards the Left-hand, you have every Fifth Minute of the *Æquinoctial*, against each of which, in the respective Columns, you have how many Minutes and Seconds of *Time* are contained therein, having relation to the Degrees of the *Æquinoctial* in the Six Lines above.

The Use of the Table.

I. *How to know how many Degrees and Minutes of* Time *are contained in any Number of Degrees and Minutes of the* Æquinoctial.

You must seek the Number of Degrees of the *Æquinoctial* above, in one of the Six Lines; and the Minutes (or the nearest Minutes you can find) in the first Column of the lower Part of the Table; and against the Minutes in the first Column, and under the Degrees in the Head, in that Common Angle, you shall have the Minutes and Seconds; and at the end of the Line above, where you found the Degrees, you shall have the Hours; as in the Examples following.

Example

Example 1. *In* 17 *deg.* 15 *min of the* Equinoctial, *how many Hours and Minutes of Time.*

Seek 17 deg. in the top of the *Table*, (which you shall find in the Second *Line*, at the end whereof stands I. or one Hour.) Also find 15 min. in the First Column of the lower part of the *Table*, and against 15 min. and under 17 deg. you shall find 9 min. which with the one Hour at the top of the *Table*, makes one Hour 9 Minutes. And so much in *Time* is contained in 17 deg. 15 min. of the *Equinoctial.*

Example 2. *In* 68 *deg.* 25 *min. of the* Equinoctial, *how many Hours and Minutes of Time?*

Look for 68 deg. in the Head of the *Table*, which you shall find in the Fifth *Line*, at the end whereof standeth IV. or Four Hours: Likewise find 25 min. in the First Column of the under part of the *Table*; and against 25, and under 68, you shall find 33 min. 40 seconds; which, with the Four Hours above, makes 4 Hours, 33 min. 40 seconds of *Time*; and so much is contained in 68 deg. 25 min. of the *Equinoctial.*

In like manner you may find, that

	D. M.		H. M. S.	
In	27 — 0 84 — 10 72 — 25	of the *Equinoctial* is contained	1 48 0 3 12 40 4 49 40	of *Time.*

II. *To find how many Degrees and Minutes of the* Equinoctial, *are contained in any Number of Hours, Minutes, and Seconds of* Time.

Seek the Minutes, (or Minutes and Seconds) in some of the Columns in the lower part of the *Table*, and note what number of Minutes of the *Equinoctial* stands against the same in the First Column. Also seek the Hours in the Head of the *Table*, and carry your Eye along that *Line*, till you come over the Column where you found the Minutes and Seconds; for those are the Degrees; and the Number in the First Column the Minutes.

Example 1. *In* 3 *Hours*, 48 *min.* 20 *Seconds of* Time, *how many Degrees and Minutes of the* Equinoctial?

First seek 48 min. 20 Seconds among the Columns in the lower part of the *Table*, (which you will find in the 14th Column,) and over it (in the *Line* at the top of the *Table*, which hath three Hours at the end of it,) you shall find 57 deg. and against 48 min. 20 sec. in the first Column you shall find 5 min. So that in 3 hour. 48 min. 20 sec. of *Time*, are contained 48 deg. 5 min. of the *Equinoctial.*

In like manner,

	H. M. S.		D. M.	
In	1 7 0 3 28 20 5 18 40	of *Time* are contained	16 45 51 50 79 40	of the *Equinoctial.*

And so of any other number of Hours, Minutes, &c.

Note here, That this *Table* extendeth but to the Degrees of one *Quadrant* of the *Equinoctial*; wherefore, if your number of Degrees of the *Equinoctial* to be reduced into *Time*, be above 90, add 6 Hours; if above 180, add 12 Hours; if above 270, add 18 Hours to what you find in the *Table.*

Some

Some Uses of the foregoing Table *of* FIXED STARS.

THE Uses of this *Table* are many, some of which follow.

USE I. *To find at what Hour any of the* Stars *in the* Table, *will be upon the South part of the* Meridian *any time of the Year.*

The RULE.

From the Right Ascension *of the* Star *in Degrees and Minutes (as found in this* Table) *subtract the* Right Ascension *of the* Sun, *in Degrees and Minutes, (as it is in the Kalendar for the Time proposed,) the Degrees and Minutes remaining (being reduced into Time, either by the little* Table *at the end of the Catalogue of* Stars, *or by allowing* 15 *deg. for one Hour, and* 4 *deg. for one Minute of Time,) shall give you the Hour and Minute that that* Star *shall be upon the South part of the* Meridian *on the day proposed.*

Note. If it so fall out (as often times it will) that the *Right Ascension* of the Sun be greater than that of the Stars, (so that subtraction cannot be made,) you must add 180 deg. to the Star's *Right Ascension*, and then the remaining Degrees (reduced into *Time* as before) will be the time that the Star will be upon the South part of the *Meridian* the next Morning.

This *Rule* shall be illustrated by *Examples.*

Example 1. *Let it be required to know at what Hour the Head of* Medusa (*called* Algol) *will be upon the South part of the* Meridian *upon the first of* February.

The *Right Ascension* of *Algol*, (or *Head of Medusa,*) according to this *Table*, is 41 deg. 46 min. And the *Right Ascension* of the Sun for the first of *February*, (by the *Table*) is 145 deg. 30 min. which being greater than 41 deg. 46 min. the Star's *Right Ascension*, I do add (according to the Note, or Caution before given) 180 deg. to the Star's *Right Ascension*, and the Summ will be 221 deg. 46 min. from which if you subtract 145 deg. 30 min. (the Sun's *Right Ascension*,) the Remainder will be 76 deg. 16 min. which reduced into *Time* (as is shewed before) is 5 hour. and 5 min. and at such time the next Morning, (*viz. February* 2.) will the Star *Algol* be upon the South part of the *Meridian.*

A *Synopsis* of this First *Example.*

	D.	M.
The *Right Ascension* of the *Head of Medusa, Algol,*	41	46
Add 180 deg.	180	00
The Summ is	221	46
The *Right Ascension* of the Sun *February* 1. subtract	155	30
The Remainder is	76	16

Which 76 deg. 16 min. converted into *Time*, is 5 hou. and 5 min. at which time in the Morning, (*February* 2.) the Star *Algol* will be upon the South part of the *Meridian*, because the Sun's *Right Ascension* was greater than that of the Star's.

I have been somewhat large in the Explanation of this *Rule*, and this first *Example*, because I intend the more brevity in those which follow:— And also, for that there is in it all the varieties that can possibly arise in any other *Example* of the like kind.

Example 2. *Let it be required to know at what time the great Star in the Skirt of* Boeotes *Garment, called* Arcturus, *doth come to the* Meridian *on the* 31*st of* May.

The *Right Ascension* of *Arcturus*, by the *Table*, is 30 deg. 13 min. The *Right Ascension* of the Sun, for the 31 of *May*, is 78 deg. 45 min. (which subtracted from the *Right Ascension* of the Star 180 deg. being added, the Summ will be 210 deg. 13 min. from which subtract 78 deg. 45 min. the *Right Ascension* of the Sun, and there rests

 131 deg.

131 deg. 48 min. which corrected into *Time* by the former *Table*, giveth 8 hours 46 min. So that *Arcturus* will be upon the *Meridian* at 46 min. after 8 the next Morning (*June* 1.)

See the following *Synopsis*.

	D.	M.
The *Right Ascension* of *Arcturus*	30	13
180 deg. add	180	
The Summ	210	13
The Sun's *Right Ascension*, *May* 31 subtract	78	45
Arcturus on the *Meridian*	131	28

That is in *Time* 8 hou. 46 min. the next Morning, *June* 1.

Example 3. *Let it be required to find at what Hour the* Great Dog, *or* Syrius, *will be upon the* Meridian *on the* 18*th of* October.

I shall use no more words to Explain this Example, but the following *Synopsis*.

	D.	M.
The *Right Ascension* of *Syrius*, the *Great Dog*	97	42
The Sun's *Right Ascension*, *October* 18. subtract	32	57
The *Great Dog* South	64	45

Which 64 deg. 45 min. being converted into *Time*, gives 4 hou. 19 min. for the time of the *Great Dog's* coming to the South the 18th of *October* in the Evening; because the Sun's *Right Ascension* was less than the Star's; so that 19 min. after 4 in the Afternoon the *Great Dog* on the 18th of *October* will be upon the *Meridian*.

The Three foregoing *Examples* have been all wrought in Degrees and Minutes of *Right Ascension*; and so at the conclusion did require a Reduction of Degrees and Minutes of *Right Ascension* into Degrees and Minutes of *Time*: Wherefore, I will work the same Three *Examples* again in Hours and Minutes of *Right Ascension* in *Time*, as they were before in Degrees and Minutes of *Right Ascension*.

Example 1. *At what time will* Algol, *or* the Head of Medusa, *be upon the* Meridian *on the First of* February?

The *Right Ascension* of *Medusa's Head*, in the *Table* of Stars, is 2 hou. 47 min. And the *Right Ascension* of the Sun on the First of *February*, in *Time*, is 9 hou. 42 min. which should be subtracted from 2 hou. 47 min. the *Right Ascension* of *Algol*; but being it is greater, add 12 Hours to the *Right Ascension* of *Algol*, and then from the Summ subtract the Sun's *Right Ascension*, the Remainder will be 5 hou. 5 min. for *Time* of *Algol*'s coming to the *Meridian* the next Morning, *February* 2. because the Sun's *Right Ascension* was greater than the Star's *Right Ascension*.

	H.	M.
The *Right Ascension* of *Algol* in *Time*	2	47
12 Hours added makes	12	00
The Summ	14	47
The Sun's *Right Ascension*, *February* 1. subtract	9	42
The time of *Algol*'s coming to the *Meridian*	5	05

Example 2. *At what Hour upon the* 31*st of* May, *will* Arcturus *be upon the* Meridian?

	H.	M.
The *Right Ascension* of *Arcturus*	2	1
12 Hours add	12	0
Summ	14	1
Sun's *Right Ascension*, *May* 31 subtract	5	15
Time of the Star's being upon the *Meridian* in the Morning, *June* 1.	8	46

Example

Example 3. *At what Hour will the* Great Dog, Syrius, *be upon the* Meridian *on the* 18*th of* October?

	H.	M.
The *Right Ascension* of *Syrius* in *Time*	6	31
Sun's *Right Ascension, October* 18	2	12
The *Great Dog, Syrius*, South at	4	19

In the Evening, becauſe the Sun's *Right Aſcenſion* was leſs than the Stars.

This way of finding the time of a Stars coming to the *Meridian* is ſomewhat eaſier than the former, becauſe the Reduction of Degrees and Minutes into Hours and Minutes is avoided —— There is yet a more expeditious way by Addition, and not Subtraction, and that is this.

The RULE.

To the Complement of the Sun's Right Aſcenſion (*found in the Sun's Kalendar*) *add the Stars* Right Aſcenſion (*found in the* Table,) *the Summ of them is the Hour and Minute of the Star's coming to the* Meridian.

Note, If the Summ of the Addition do exceed 12 Hours, take 12 therefrom, and the Remainder will be the time that the Star will be upon the *Meridian* in the Evening.— But if the Summ be leſs than 12 Hours, it will give the time of the Star's coming to the *Meridian* the next Morning.

I will make this *Rule*, and the *Note* upon it, plain, by the Three foregoing *Examples*, wrought by this way of Addition only.

Example 1. *At what time*, February 1. *will* Algol *be upon the* Meridian?

The *Synopſis*.

	H.	M.
The Complement of the Sun's *Right Aſcenſion, Feb.* 1.	2	18
The *Right Aſcenſion* of *Meduſa*'s Head, *Algol*	2	47
Algol comes to the *Meridian* at	5	05

The next Morning (*Feb.* 2.) becauſe the Summ is leſs than 12 Hours.

Example 2. *At what time upon the* 31*ſt of* May, *will* Arcturus *be upon the* Meridian?

	H.	M.
Complement of the Sun's *Right Aſcenſion, May* 31.	6	45
The *Right Aſcenſion* of *Arcturus*	2	01
Arcturus comes to the *Meridian* at	8	46

The next Morning, (*June* 1.) becauſe the Sun is leſs than 12 Hours.

Example 3. *At what time upon the* 18*th of* October, *will* Syrius, the Great Dog, *be upon the* Meridian?

	H.	M.
The Complement of the Sun's *Right Aſcenſion, Oct.* 18.	9	48
The *Right Aſcenſion* of the *Great Dog, Syrius*	6	31
Syrius comes to the *Meridian* at	16	19

From which take 12 Hours, and there remains 4 hou. and 19 min. at which time in the Evening, *Oct.* 18. (becauſe the Summ exceeded 12 Hours) *Syrius* will be upon the *Meridian*.

Thus have you Three ways to find the *Time* that any Star in the *Table* will be upon the South part of the *Meridian*, and you ſee (by obſerving the *General Rules*) that they all agree, ſo that every Man may uſe that way which he beſt liketh: and ſo this ſhall ſuffice for the firſt Uſe of this *Table*.

USE II. *To find any Day of the Year, at what Hour any Star in the Table doth riſe and ſet.*

For this purpoſe in the Table of Stars you have a Column whoſe Title is *Semidiurnal Ark*, by help whereof (having the Time of the Star's coming to the *Meridian*) you may find the Time of the Star's Riſing and Setting, by the Directions following.

The RULE.

From the Time that any Star comes to the Meridian, *ſubtract the* Semidiurnal Ark *of that Star, and the Remainder ſhall be the Time of the Star's Riſing.* Alſo, *If to the Time of any Star's coming to the* Meridian, *you add the* Semidiurnal Ark *of that Star, the Sum ſhall be the Hour and Minute of that Star's ſetting. But (if Subtraction cannot be made) add Twelve Hours where Occaſion ſerves.*

Example 1. *At what Hour, upon the 2d. of* February, *will the Star* Algol *riſe and ſet?*

By the foregoing Examples you found, that *Algol* came to the *Meridian* on the 2d. of *February*, at 5 Hours and 5 min. in the Morning; which known, look for the Star *Algol* (the *Head of Meduſa*) in the Table of Stars, and againſt it (under the Title of *Semidiurnal Ark*) you ſhall find theſe Words, [*Sets not*]; which ſhews, that *Algol* (in this Latitude of *London*, 51 deg. 30 min. for which the Tables in this Book are calculated) never ſets, nor never riſes, but is always above the *Horizon*: So that this Example is impertinent in this Latitude, though this Star riſes and ſets in other Latitudes. And to be aſcertained of what Stars do riſe and ſet in any Latitude, obſerve this

GENERAL RULE.

If the Declination of any Star (found in the Table) having North Declination in North Latitude, do exceed the Complement of the Latitude of the Place you would know the Time of his or Setting Riſing in, you may conclude, that that Star never riſes nor ſets in that Latitude.

As in this Example, the Declination of *Algol* is 39 deg. 39 min. North; which being greater than 38 deg. 30 min. the Complement of the Latitude of *London*, you may conclude, that it never riſes nor ſets in that Latitude.

And, *If the Declination of the Star be equal to the Complement of the Latitude*, (as the Bright Star in the *Harp*, called ſometimes *Lucida Lyra*, whoſe Declination is 38 deg. 30 min.) *that Star doth only touch the North part of the* Meridian, *upon the very Verge of the* Horizon, *but never riſes nor ſets.*

Alſo, *Thoſe Stars whoſe Declinations are South, and greater than the Complement of the North Latitude you are in, do never to us riſe or ſet, but are always hid from our ſight, under the* Horizon.

Example 2. *At what Hour upon the 18th. of* October *doth the great Dog* Sirius *riſe and ſet?*

By the foregoing Examples you found, that the *Great Dog* was upon the *Meridian* on the 18th. of *October*, at 19 min paſt Four in the Evening; and (by the Table of Stars) you find that his *Semidiurnal Ark* is 4 ho. 34 min. which ſubtracted from 4 ho. 19 min. the Time of the Star's Southing, the Remainder is 11 ho. 45 min. for the Time of the Star's Riſing; and being added thereto, the Summ is 8 ho. 53 min. the Time of the Star's Setting.

The

	H.	M.	
The *Great Dog* South, *October* 18	4	19	Evening.
His *Semidiurnal Arch*, subtract	4	34	
Leaves the Time of the Star's Rising	11	45	Before Noon.
And the *Semidiurnal Ark* added, gives the Time of the Star's Setting———	8	53	Evening.

Example 3. *At what time upon the First of* June *will* Arcturus *rise and set?*

	H.	M.	
Arcturus South upon the First of *June* at	8	46	Morning.
His *Semidiurnal Ark* subtracted	7	55	
Leaves the Time of the Star's Rising	0	51	Morning.
And the *Semidiurnal Ark* added makes	16	41	
From which subtract	12	00	
Leaves the Time of the Star's Setting	4	41	After Noon.

USE III. *To find what* Latitude *you are in, at any time when the Stars appear, by taking of the Star's* Meridian Altitude, *and finding of his* Declination *in this Table.*

In finding of the *Latitude* by the *Meridian Altitude* of a Star, and his *Declination*, there are several various Workings to be observed.

(1.) According to the Situation of the Star, he having North or South *Declination*.

(2.) In respect of your observing his *Altitude*, whether he be upon the North or South part of the *Meridian*.

(3.) And in respect of the Part of the World in which you are.

Examples of all which Varieties I shall give in these few brief Rules.

1. If the Star have no *Declination*, and you observe his *Meridian Altitude* on the	*NORTH* Side of the *Meridian*,	Subtract the *Meridian Altitude* from 90 deg. the Remainder is the *Latitude South*.
	SOUTH Side of the *Meridian*,	Subtract the *Meridian Altitude* from 90 deg. the Remainder is the *Latitude North*.
2. If the Star's *Declination* be	*SOUTH*,	And the *Meridian Altitude* less than 90 deg. and the Star upon the South-side of the *Meridian*, add the *Meridan Altitude* and *Declination* together, which taken from 90 deg. the Remainder is the *Latitude North*. But if the Summ exceed 90 deg. take 90 from it, the Remainder is the *Latitude South*.
	NORTH,	And the *Meridian Altitude* less than 90 deg. and the Star upon the South-side of the *Meridian*, subtract the Star's *Declination* from his *Meridian Altitude*, and the Remainder taken from 90 deg. gives the *Latitude North*.

3. If the Star's *Declination* be

- *SOUTH*, — And the *Meridian Altitude* be less than 90 deg. and the Star upon the North side of the *Meridian*, subtract the *Declination* from the *Meridian Altitude*, and the Remainder taken from 90 deg. leaves the *Latitude South*.
- *NORTH*, — And the *Meridian Altitude* less than 90 deg. and the Star upon the North side of the *Meridian*; the Summ of the *Altitude* and *Declination* taken from 90 deg. leaves the *Latitude South*. But if the Sum be more than 90 deg. the Remainder above 90 is the *Latitude North*.

If the Star's *Declination* be {*South*, *North*,} and the *Meridian Altitude* be just 90 deg. the Star's *Declination* is the *Latitude* {*South*. *North*.}

If the *Meridian Altitude* be observed within the Bounds of the *Polar Circles*, in this Case the Star's *Declination* must be taken from 90 deg. and the Remainder is the Star's *Distance* from the *Pole*; which added to the *Meridian Altitude*, gives the *Latitude*.

¶ Note, *That these are all the Varieties that can possibly happen at any time, in any Part of the World: And what is here said of the* Stars, *the same is to be understood of the* Sun *also. And therefore these* Rules *will serve for the* Sun's Meridian Altitude *also, by changing the Word* Star's *for* Sun's, *&c. And I place those* Rules *here the rather, for that they will be more serviceable to Seamen, than to observe by the* Sun, *for these Reasons.*

1. Because you can have the *Sun* upon your *Meridian* but once in 24 Hours, there being but one *Sun* in the Firmament. And,
2. Because there are infinite of *Stars*, and at any time that the *Stars* may be seen, some or other of them will be always upon the *Meridian*; so that you may make several Observations of them in a short time.

Rules to find the Latitude *by the* Sun's Meridian Altitude *and* Declination.

CASE I. If the *Sun* be on the *Meridian* to the *Southwards*, and have *South Declination*,

Add the *Sun's Meridian Altitude* and *Declination* together, the total taken from 90 deg. leaves the *Latitude North*.

	D.	M.
The *Sun' Declination* Southerly	20	00
The *Sun's Meridian Altitude* observed	17	55
Their Summ	37	55
Which subtracted from 90 deg. or	89	60
There remains the *Latitude North*	52	05

But if the Summ of the *Meridian Altitude* and *Declination* do exceed 90 deg. subtract 90 deg. from it, and the Remainder is the *Latitude South*.

	D.	M.
The *Sun's Declination South*	20	11
The *Meridian Altitude* by Observation	70	35
Their Summ	90	46
From which subtract 90	90	00
There remains the *Latitude South*	00	46

CASE

CASE II. If the Sun be on the *Meridian* to the Southwards, and have North Declination.

Subtract the Sun's Declination from the *Meridian Altitude*, and that which Remains subtract from 90, the last Remainder is your *Latitude* North.

	D.	M.
The *Sun's Declination* Northerly	15	10
The *Meridian Altitude* observed	64	22
The *Declination* subtracted, the Remainder is	49	21
Which subtracted from 90	89	60
There Remains the *Latitude* North	40	39

CASE III. If the Sun be on the *Meridian* to the Northwards, and have North *Declination*.

Add the *Sun's Declination* and *Meridian Altitude* together, the Total taken from 90, the Remainder is the *Latitude* South.

But if the Total exceed 90 deg. subtract 90 deg. from it, and the Remainder is the *Latitude* North.

CASE IV. If the *Sun* be Northward at Noon, and have South *Declination*.

Subtract the *Declination* from the *Meridian Altitude*, and that which Remains subtract from 90 deg. the last remainder is the *Latitude* South.

CASE V. If you observe when the *Sun* hath no *Declination*;

The *Meridian Altitude* observed when the *Sun* hath no *Declination*, the *Meridian Altitude* taken from 90 deg. is the *Latitude*.

CASE VI. If you observe when the *Sun* is in the *Zenith*.

Look in the *Table* for the *Sun's Declination* that day, for that is your *Latitude*.

CASE VII. If the *Sun* come to the *Meridian* beneath the *Pole*.

If you be within the *Arctick* or *Antarctick* Circles, and observe the *Sun* upon the *Meridian* under the *Pole*, subtract the *Sun's Declination* from 90, the Remainder is the *Sun's* Distance from the *Pole*; which added to his *Meridian Altitude*, the *Summ* is the *Latitude*.

What is said here concerning the *Sun*, the like is to be understood of the *Stars* also.

Of Magnetical Inclination, *and how to know the* Latitude, *by the* Dipping Needle, *without the help of* Sun *or* Stars.

THE *Inclinatory Needle*, was the Useful invention of Dr. *Butler*, and hath been since approved of by divers learned Men of this, as well as of former Ages; It is now contrived so as to hang in a broad Brass Ring, within two Glasses to keep the Needle from the Air; in the Brass Ring are two *Quadrants* divided into 90 Degrees, and the Needle hangs upon an *Axis*, playing upon two Pevets: This Instrument is placed in a Box, and so ordered to hang therein, that the Ship moving up and down, the Instrument hangs Perpendicular and Horizontal also, as the common Compass doth. The Needle in this Brass Frame between the Glasses (before it be touched with the Load Stone) is made to hang upon its *Axis* Horizontal, but when it is touched it hath an inclination, respecting a certain Point of Elevation or Depression, according to the *Latitude* wherein it is used: And the Depressions are such, in every Degree of *Latitude*, as in this *Table* is expressed.

A TA-

A TABLE of Magnetical Inclination.

Latitude.	*Magnetical Inclination.*		*Latitude.*	*Magnetical Inclination.*		*Latitude.*	*Magnetical Inclination.*		*Latitude.*	*Magnetical Inclination.*	
D.	D.	M.	D.	D.	M.	D.	D.	M.	D.	D.	M.
0	00	00	23	41	39	46	68	24	69	83	40
1	02	11	24	43	6	47	69	17	70	84	7
2	04	20	25	44	30	48	70	9	71	84	32
3	06	27	26	45	54	49	70	59	72	84	57
4	08	31	27	47	15	50	71	48	73	85	21
5	10	34	28	48	36	51	72	36	74	85	44
6	12	34	29	49	54	52	73	23	75	86	7
7	14	32	30	51	11	53	74	8	76	86	28
8	16	28	31	52	27	54	74	52	77	86	48
9	18	22	32	53	41	55	75	35	78	87	8
10	20	14	33	54	53	56	76	17	79	87	26
11	22	4	34	56	4	57	76	57	80	87	44
12	24	52	35	57	13	58	77	37	81	88	1
13	25	38	36	58	21	59	78	15	82	88	17
14	27	21	37	59	28	60	78	52	83	88	33
15	29	4	38	60	33	61	79	29	84	88	47
16	30	45	39	61	37	62	80	4	85	89	1
17	32	24	40	62	39	63	80	38	86	89	14
18	34	0	41	63	40	64	81	11	87	89	27
19	35	36	42	64	39	65	81	43	88	89	39
20	37	9	43	65	38	66	82	13	89	89	50
21	38	41	44	66	15	67	82	43	90	90	0
22	40	11	45	67	30	68	83	12	—	—	—

Of

Of the North-Star, *and how to find the* Latitude *thereby.*

	The True Points of the Compaſs.	*A Table of the* North-Star *in theſe ſeveral* Latitudes. 0		20		30		40		50		60		70		Of Declinat.	The old way of Reckoning the Points of the Compaſs.
		D.	M.	D.	M	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.		
If the former of the *Guards* be aſcending from North, or lower part of the *Meridian.*	North	2	10	2	10	2	10	2	9	2	9	2	8	2	7	Above the *Pole.*	South
	N by E	1	53	1	53	1	53	1	52	1	52	1	51	1	49		S by E
	N N E	1	31	1	31	1	30	1	30	1	29	1	28	1	25		S S E
	N E by N	1	6	1	5	1	4	1	3	1	2	1	1	0	58		S E by S
	N E	0	39	0	38	0	37	0	36	0	35	0	33	0	30		S E
	N E by E	0	10	0	9	0	0	0	7	0	6	0	4	0	1		S E by E
	E N E	0	18	0	19	0	20	0	22	0	22	0	23	0	26	Under the *Pole.*	E S E
	E by N	0	49	0	50	0	50	0	51	0	52	0	53	0	56		E by S
	Eaſt	1	15	1	15	1	16	1	17	1	18	1	19	1	21		Eaſt
	E by S	1	38	1	39	1	39	1	40	1	41	1	42	1	44		E by N
	E S E	2	0	2	0	2	0	2	1	2	1	2	2	2	2		E N E
	S E by E	2	15	2	15	2	15	2	16	2	16	2	16	2	16		N E by E
	S E	2	25	2	25	2	25	2	25	2	25	2	25	2	25		N E
	S E by S	2	30	2	30	2	30	2	30	2	30	2	30	2	30		N E by N
	S S E	2	29	2	29	2	29	2	29	2	29	2	29	2	29		N N E
	S by E	2	22	2	21	2	22	2	22	2	22	2	22	2	22		N by E
If the former of the *Guards* be aſcending from South, or upper part of the *Meridian.*	South	2	10	2	17	2	10	2	11	2	11	2	11	2	12	Under the *Pole.*	North
	S by W	1	58	1	53	1	54	1	53	1	55	1	55	1	57		N by W
	S S W	1	31	1	32	1	32	1	33	1	34	1	35	1	38		N N W
	S W by S	1	7	1	7	1	8	1	10	1	10	1	11	1	13		N W by N
	S W	0	39	0	40	0	41	0	40	0	43	0	44	0	47		N W
	S W by W	0	10	0	11	0	12	0	13	0	14	0	16	0	19		N W by W
	W S W	0	19	0	18	0	17	0	16	0	15	0	13	0	10	Above the *Pole.*	W N W
	W by S	0	48	0	47	0	46	0	45	0	44	0	43	0	42		W by N
	Weſt	1	14	1	14	1	13	1	11	1	11	1	10	1	8		Weſt
	W by N	1	39	1	39	1	38	1	37	1	36	1	35	1	33		W by S
	W N W	1	59	1	59	1	59	1	58	1	58	1	57	1	56		W S W
	N W by W	2	15	2	15	2	14	2	14	2	14	2	13	2	12		S W by W
	N W	2	25	2	25	2	25	2	25	2	25	2	24	2	24		S W
	N W by N	2	30	2	30	2	30	2	30	2	30	2	30	2	30		S W by S
	N N W	2	29	2	29	2	29	2	29	2	29	2	29	2	29		S S W
	N by W	2	22	2	22	2	22	2	22	2	22	2	21	2	21		S by W

The Uſe of this Table.

WHen you would obſerve the *Altitude* of the *North-Star*, mark as near as you may upon what Point of the Compaſs the former *Guard* of the *Little Bear* is: But if the Star be not upon a juſt full Point of the Compaſs, ſtay a while, till it come to be upon one; and then take the Height of the *North-Star* as exactly as you can. Then knowing within a Degree or two what *Latitude* you are in, ſee which *Latitude* in this Table is neareſt thereunto, and uſe that Column. Then find the Point of the Compaſs that the *Guard-Star* is upon in the firſt or laſt Column of the Table, and in the Column under your neareſt *Latitude* you ſhall find how many Degrees and Minutes the *Pole-Star* is either above or under the *Pole.* If the *Star* be above the *Pole*, ſubtract the Number in the Table from the *Altitude* Obſerved, and the Remainder is the *Latitude:* But if the *Star* be under the *Pole*, add the Number in the Table to the Height Obſerved, and the Summ thereof is the *Latitude.*

A Table

A TABLE *of the* Procession, *or* Retrogression *of the* Fixed Stars, *whereby their true Places in* Longitude *may be known for any time past or to come.*

Years.	*Progression of the Fixed Stars in Longitude.* D.	M.	S.	*Years.*	*Progression of the Fixed Stars in Longitude.* D.	M.	S.	*Years.*	*Progression of the Fixed Stars in Longitude.* D.	M.	S.	*Years.*	*Progression of the Fixed Stars in Longitude.* D.	M.	S.
0	0	0	0	30	0	25	0	60	0	50	0	90	1	15	0
1	0	0	50	31	0	25	50	61	0	50	50	91	1	15	50
2	0	1	40	32	0	26	40	62	0	51	40	92	1	16	40
3	0	2	30	33	0	27	30	63	0	52	30	93	1	17	30
4	0	3	20	34	0	28	20	64	0	53	20	94	1	18	20
5	0	4	10	35	0	29	10	65	0	54	10	95	1	19	10
6	0	5	0	36	0	30	0	66	0	55	0	96	1	20	0
7	0	5	50	37	0	30	50	67	0	55	50	97	1	20	50
8	0	6	40	38	0	31	40	68	0	56	40	98	1	21	40
9	3	7	30	39	0	32	30	69	0	57	30	99	1	22	30
10	0	8	20	40	0	33	20	70	0	58	20	100	1	23	20
11	0	9	10	41	0	34	10	71	0	59	10	200	2	46	41
12	0	10	0	42	0	35	0	72	11	0	0	300	4	10	1
13	0	10	50	43	0	35	50	73	01	0	50	400	5	33	22
14	0	11	40	44	0	36	40	74	01	1	40	500	6	56	42
15	0	12	30	45	0	37	33	75	1	2	30	600	8	20	3
16	0	13	20	46	0	38	20	76	1	3	20	700	9	43	23
17	0	14	10	47	0	39	10	77	01	4	10	800	11	6	44
18	0	15	0	48	0	40	0	78	01	5	0	900	12	30	4
19	0	15	50	49	0	40	50	79	01	5	50	1000	13	53	25
20	0	16	40	50	0	41	40	80	01	6	40	2000	27	46	50
21	0	17	30	51	0	42	30	81	01	7	30	3000	41	40	15
22	0	18	20	52	0	43	20	82	01	8	20	4000	55	33	40
23	0	19	10	53	0	44	10	83	01	9	10	5000	69	27	5
24	0	20	0	54	0	45	0	84	01	10	0	6000	83	20	30
25	0	20	50	55	0	45	50	85	01	10	50	7000	97	13	55
26	0	21	40	56	0	46	40	86	1	11	40	8000	111	7	20
27	0	22	30	57	0	47	30	87	1	12	30	9000	125	00	45
28	0	23	20	58	0	48	20	88	1	13	20	10000	138	54	10
29	0	24	10	59	0	49	10	89	1	14	10				

The Use of the foregoing Table *of the* Retrogression *and* Progression *of the* Fixed Stars *in* Longitude.

THE *Catalogue* of *Fixed Stars,* before given, has the Places in *Longitude* exactly calculated for the Year of Christ 1671: And although the *Table* will serve (without any sensible difference) for many Years before and after 1671, because their *Progression* in *Longitude* is but small, namely but one Degree in 72 Years (as this *Table* apparently shews,) yet, being I have framed *Tables* for the finding of the true

true Places of the *Sun* and *Moon* in *Longitude*, for any time past or to come, I held it convenient to do the like for the *Fixed Stars*: And how to effect it by this *Table*, this is the

RULE.

The Radix *of the* Table *being for the Year* 1671. *If you would find the true Place of any* Fixed Star *in* Longitude *for any Years past; subtract the Years from the* Radix 1671, *and you shall find the Difference.— But if the* Star's *Place be required for any Years to come, subtract the* Radix 1671, *from the Year proposed, and the Difference shall give you the Interval or Space between the time proposed and the* Radix.— *With which Interval (or Difference) enter this* Table, *and find the* Retrocession *or* Progression *of the* Star *in that Interval; which being added to, or subtracted from, the* Longitude *found in the* Catalogue, *shall give you the true* Place *of the* Star *in* Longitude *for the Year proposed.*

Example 1. *Let it be required to find what was the true Place of* Aldebaron *(or the* Bull's Eye*) in* Longitude *in the Year of our Lord* 515.

From the *Radix* 1671 subtract 515, the residue 1156 is the Interval of Years between the time proposed and the *Radix*; the *Retrocession* whereof I collect from this *Table* in this manner,

Year.	D.	M.	S.		D.	M.	S.
1000	13	53	25	Place of *Aldebaron* 1671.	65	12	30
100	0	23	20	*Retrocession* in 1156 Years, subtract	16	03	25
56	1	46	40				
1156	16	03	25	Place of *Aldebaron, Anno Christi* 515.	49	09	05

That is in 19 deg. 9 min. 5 seconds of *Taurus*.

Example 2. *Let the Place of* Aldebaron *be required for the Year* 1910.

From the Year given 1910, subtract the *Radix* 1671, the Difference 239 is the Interval; which collect from this *Table*, and add it to the *Radix* in this manner,

Year.	D.	M.	S.		D.	M.	S.
200	2	46	41	Place of *Aldebaron* 1671	65	12	30
39	0	32	30	*Progression* in 239 Years, add	3	19	11
239	3	19	11	True Place of *Aldebaron, Anno Christi* 1910.	68	31	41

That is, in 8 deg. 31 min. 41 sec. of *Gemini*.

CURSUS

CURSUS MATHEMATICUS.

BOOK VIII.

OF DIALLING:

ARITHMETICAL, GEOMETRICAL, INSTRUMENTAL,

WHEREIN
The Doctrine of *PLAIN* and *SPHERICAL TRIANGLES* is applied to Practice in that *ART*.

ALSO OF
PROJECTIVE and REFLECTIVE DIALS:
And Variety of other
SHADOWS.

By *WILLIAM LEYBOURN*, Philomathemat.

LONDON,
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OF
DIALLING.

Prœem.

Concerning this Sciographical *Art, who was the first Inventor thereof is hard to determine: But the first* Gnomonical Organ *which stands upon Record* 2 Reg. 20. 11. *is the Dial of King* Ahaz; *whereby the Almighty was pleas'd to express a Miracle for the Recovery of King* Hezekiah, Esay. 38. 8. *and moved the* Babylonish Ambassadors, 2 Chron. 32. 31. *to enquire of the Wonder which was done in the Land. What kind of* Dial *this was is also uncertain, but Authors generally suppose it to be either a* Convex *or (rather)* Concave Hemisphere, *those being afterwards* Dials *familiar among the* Chaldeans. *Some there are who crown* Anaximenes, *the* Lacedemonian, *with giving the first breath to this Science. It crept into* Rome *later, (but after a rude manner;) for* Accensus *the* Consul *determined only the* Noon-tide, *and that only in serene Days: And no farther Light had they, till the* Consul M. Val. Messala *beautified a* Column *with a* Dial *near the* Rostra, *as* Varro *relates. The Invention of the* excavated Hemisphere *is attributed to* Berosus, *the* Chaldean, *after the taking of* Catana *in* Sicily: *But others attribute it to the witty* Samian Aristarchus, *as first shadowing out the* Hour-Lines *on a* Plain. *Yet sure, the* Scaphe *or* Concave Hemisphere *was in use before his time, for* Eratosthenes, *before him, determined by* Shadows *some* Celestial *and* Terrestrial Distances; *but upon what kind of* Superficies *is not said. And now, since both the first Invention and the Inventor of this most* Celestial Science *are buried in oblivion, I shall in this following* Tractate *expose to publick view, in what lustre it is in this our Time arrived unto.*

Arithmetical DIALLING.

PART I.

Shewing how to describe the Hour-Lines, Stile, Substile, Meridian, Horizon, *&c. upon all sorts of* Dial Plains, *by* Trigonometrical Calculation; *deduced from the* Sphere *it self, it being* Projected in Plano, *suitable to any* Horizon; *In which* Projection, *all such* Spherical Triangles *as appertain to the finding of the above mentioned* Requisites, *are discovered and resolved.*

IN the *Third Book* of *Practical Astronomy*, in the first Part thereof, I have largely treated of the *Doctrine of the Sphere*, and of the *Circles* thereof, and to what uses each of them is appropriate: And in the *Second Part* of the said *Third Book*, I have treated of the *Doctrine* of *Spherical Projection*, shewing how to *Project* the *Sphere in Plano* upon any of the *Great Circles* thereof. Also in the *Second Part* of the *Fourth Book* of *Trigonometry* I have shewed how the Doctrine of *Spherical Triangles* is to be performed by *Spherical Projection*, in both which the Reader ought (at least in some measure) to be acquainted, before he enter upon the Practice of this *Treatise*; for so shall he find what is herein delivered very familiar and easie: And therefore I shall say nothing of either of them in this Place, but proceed to the matter in hand, *viz. Dialling*; and that by *Trigonometrical Calculation*.

CHAP. I.

Of the several sorts of Dial Plains.

A *Sun Dial* may be drawn upon any *Plain Superficies* in any Latitude, and the *Hour Lines* so drawn are *Great Circles* of the *Sphere*, but being projected upon a *Plain Superficies* become streight Lines.

Now all *Plains* are situate in one or other of these Three Positions, in respect of the *Horizon* of the *Place* wherein the *Dial* is made; for all *Plains* are either

$$\left.\begin{array}{l}\textit{Parallel}\\ \textit{Perpendicular}\\ \textit{Oblique}\end{array}\right\}\text{ To the } \textit{Horizon} \text{ of the Place.}$$

1. *Parallel* to the *Horizon*: (or Level thereunto) and such are called *Horizontal Plains* or *Dials*.

2. *Perpendicular* to the *Horizon* (or *erect* thereunto) and such are all *Plains* (or *Dials*) standing against any upright *Wall* or *Building*; and these are of two sorts, either *Direct* or *Declining*. For, (1.) If the *Wall* or *Plain* doth directly behold the true *East*, *West*, *North*, or *South Points* of the *Horizon*, the *Dial* made upon such a *Plain* is called an *Erect Direct*, *East*, *West*, *North* or *South Plain*. But (2.) If the *Wall* or *Plain* do not directly respect one of these four *Cardinal Points* of the *Horizon*, then it lieth open to Two of them, for it must necessarily lie open to the *South* and the *East*, or the *South* and the *West*; and accordingly it is denominated, and called an *Erect South Plain*, declining *East* or *West*; but if it lie open to the *North*, and *East* or *West*, it is called an *Erect North Plain* declining *East* or *West*.

3. Ob-

3. *Oblique*, (or *Reclining* from the *Zenith*, or *Inclining* to the *Horizon*,) and these also are of two sorts, namely, *direct Reclining*, or *Declining* and *Reclining*: For if the *Reclining Plain* do lie open to the true *East*, *West*, *North*, or *South* points of the *Horizon*, then it is call'd a *direct East*, *West*, *North* or *South Recliner*; but if it lie open to (or do behold) the *South-East* or *South-West*, the *North-East* or *North-West*, it is then called a *Reclining Plain*, *Declining* from the *North* towards the *East* or *West*: Or a *Reclining Plain*, *Declining* from the *North* towards the *East* or *West*.

These *Reclining Plains* are best represented by the *Roof* of an ordinary *House*, as the Tiling; and of these I shall hereafter call those *Recliners*, whose upper faces behold the *Zenith* of the *place*, as the Tiles of all *Houses* do; and the under faces of them, which respect or look down to the *Horizon*, I call *Incliners*.

According to this description, the number of *Dial Plains* are 25, which I shall reduce to 17, by supplying of the *Inclining Plains* with the hours of the *Reclining Plains* opposite to them, for they are indeed the same *Examples*, of all which 17 *Varieties* shall follow in due place.

CHAP. II.

How to find the Declination *and* Reclination *of a* Plain.

HAving in the foregoing *Chapter*, given you an account of such *Plains* and their *Positions*, upon which Dials are usually made; it will be necessary, before you can describe *Hour Lines*, *&c.* upon any *Plain* proposed, first, to know the quantity of its Situation; that is, (1) whether it be truly *Horizontal*; (2) or whether it be truly *Perpendicular* to the *Horizon*; (3) or whether it do *Recline* from the *Zenith*, and *Incline* to the *Horizon*; (4) or whether any such *Plain* do directly behold the true *North*, *South*, *East*, or *West* points of the *Horizon*; and if they do not, (5) to find how much they *deviate*, or *decline* from either of those *Four Cardinal points*, and *which way*: And to find all these, shall be the work of this *Chapter*. But before the *Declination* of a *Plain* can be attained, there are required two *Observations* to be made at one instant of time, when the Sun shineth upon the *Plain*; and those never after the hour of 10 in the Forenoon, nor before 2 in the Afternoon, but the *earlier* in the *Morning*, or *later* in the *Evening* are the best times: The first is to find the *Horizontal Distance* of the *Sun*, from the *Pole* of the *Plain*; the second is of the *Sun's Altitude*, thereby to get the *Azimuth*; these two Observations, as I said before, ought to be made at one instant of time, as near as may be, that the parts of the work may agree together the better, and may best be done by two persons, one to take the *Sun's Altitude*, and the other the *Horizontal Distance*.

§ I. *For the* Horizontal Distance *of the* Sun *from the* Pole *of the* Plain.

APply one edge of a *Quadrant* to the *Plain*, so that the other may be Perpendicular to it, and the *Limb* of the *Quadrant* towards the *Sun*; and hold the whole *Quadrant*, parallel to the *Horizon*, as near as you can conjecture: Then holding a *Thred* and *Plummet* at full liberty, so that the shadow of the *Thred* may pass both through the *Centre* and *Limb* of the *Quadrant*; and carefully then observe what degrees of the *Limb* are cut off by the shadow of the *Thred*, numbring them (always) from that side of the *Quadrant* that standeth *Perpendicular* from the *Plain*; for those degrees so cut by the Shadow of the *Thred*, are the degrees of the *Sun's Horizontal Distance* from the *Pole* of the *Plain*.

§ II. *How to observe the* Sun's Altitude.

TAke your *Quadrant* in both your hands, laying your *Right Hand* somewhat near that side which hath the *Sights*, and your *Left Hand* towards the other side; by which means you may let it slip lower, or raise it higher, as occasion requires. Then turning the left side of your *Body* to the *Sun*, move the *Quadrant* up and down, till the Sun, shining through that *Sight* which is next the *Centre* of the *Quadrant*, do

do cast its *Ray*, or *Beam of Light*, upon the *Hole* of the other *Sight*; the *Thred* and *Plummet*, all this time, playing at free liberty; and then look in the *Limb* of the *Quadrant*, what *degrees* and part of a *Degree*, are cut by the *Thred*, for those *degrees* are the *degrees* of the *Sun's Altitude* at that time.

By help of these two Observations, *the* Declination *of any* Plain *may be attained at any time of the* day, *and any time of the* year : *But first you must find the Sun's* Azimuth *from the* North *or* South *for the same time; and to find it shall be taught in the following Section.*

§ III. *To find the Sun's* Azimuth *at any time of the day.*

THE Sun's *Azimuth* may be found several ways taught already is this Book, as by the *Celestial Globe*, Book 3. Part 1. Prob. 18. by several *Spherical Projections*, and by *projecting* of the *Sphere in Plano*, as in Book 3. Part 2. and in divers other places of Book 4 and 5. But the way which I will here deliver, shall be by *Trigonometrical Calculation*, because my intent in this VIII Book, is to apply the *Doctrine* of *Spherical Triangles* to practice in *Dialling*, and resolving of *Problems* to that Art belonging.

The Sun's *Azimuth* is form'd by the XI of *Olique angled Spherical Triangles*.

Example. Upon *Monday* the 14th of *April*, 1690. in the Morning, I was required to take the *Declination* of *a Plain*, whereon to make a *Dial*, in *London*, whose Latitude is 51 Degrees, 32 Minutes.

First, I applied the side of my *Quadrant* to the *Plain*, horizontally, and found the *Horizontal Distance* of the *Sun* from the *Pole* of the *Plain* to be 70 degrees *Eastward* of the *South*; and at the same time, the Sun's *Altitude* I observed to be 27 deg. from whence I compute the Sun's *Azimuth* as followeth.

First, By the Intersection of the Arches of three *Great Circles* of the *Sphere* (as is at large declared, both in the III. and IV. Books foregoing) is constituted an *Oblique Angled Spherical Triangle* Z ⊙ P, such as you see in the following Figure, in which there is given the three sides, *viz.* (1) Z P, the *Complement of the Latitude* 38 deg. 28 min. (2) Z ⊙, the *Complement of the Sun's Altitude* observed, 63 deg. (3) ⊙ P, the *Complement of the Sun's Declination*, (or the Sun's Distance from the *Elevated Pole*) 76 deg. 56 min. And it is required to find the *Angle* at Z, which is the Sun's *Azimuth* from the *North* part of the *Meridian*: Which to perform, *add* the three *sides* together, and find the *summ* of them. Then, from half that *summ* take the *Complement of the Sun's Declination*, and note the difference, as is here done.

		Deg.	Min.		Deg.	Min.
April 14, 1690. Morning,	Latitude,	51	32	its Comp.	38	28
	Sun's Altitude,	27	00		63	00
	Sun's Declination, *No.*	13	04		76	56
				Their Summ,	178	24
				The half Summ,	89	12
The difference between the Complement of the Sun's Declination and the half Summ.					12	16

Being thus prepared, the Sun's *Azimuth* may be found by these two *Analogies* following.

(1)	As *Radius*, s. 90 deg.	10.00000
	Is to the Sign of Z ⊙, the Co-Altitude 63 d. 00'.	9.94988
	So is the Sign of Z P, the Co-Latitude, 38 d. 28 m.	9.79383
	To the Sign of 33 d. 39 min.	19.74371
(2)	As the Sign of 33 d. 39 min. Co-Ar.	0.25629
	Is to the Sign of the half Summ, 89 d. 12 m.	9.99995
	So is the Sign of the Difference 12 d. 16 m.	9.82728
	To this Sign,	19.58352
	The half whereof is	9.79176

Which

Which is the Sign of 38 deg. 15 min. whose Complement 51 deg. 45 min. being doubled, is 103 deg. 30 min. which is the Sun's *Azimuth* from the *North* part of the *Meridian*: Wherfore its Complement to 180 deg. being 76 deg. 30 min. is the Sun's *Azimuth* from the *South*: And the Complement thereof 90 deg. *viz.* 12 deg. 30 min. is the Sun's *Azimuth* from the *East*, it being in the Forenoon that the *Observation* was made.

Another way to Calculate the Sun's Azimuth.

Take half the difference between the Complement of the *Latitude*, and the Complement of the *Altitude*, and add it to half the Complement of the Sun's *Declination*; and also subtract it from the same, noting the *summ* and *difference*. Which done, Sun's observe this

RULE.

To the Complement Arithmetical, of the Signs of the Co-Latitude and Co-Altitude; Add the Signs of the Summ and Difference before found: Half that Summ shall be the Sign of half the Azimuth *from the* North.

As in the foregoing Examples.

	D. M.
Co-Lat.	38.28
Co-Alt.	63.00
Difference,	24.32
half Differ.	12.16
½ Co-☉ d.	38.28
Summ	50.44
Difference,	26.12

Z P, Co-Latitude 38 d. 28 m. Co-Ar.	0.20616
Z ☉, Co-Altitude 63 d. 00. Co-Ar.	0.05012
Sign of the Summ 50.44	9.88885
Sign of the Differ. 26.12	9.64493
The Summ of all,	19.79006
The half,	9.89503

Which is the Sign of 51 deg. 45 min. and is the Sun's *Azimuth* from the *North* part of the *Meridian*, as in the former *Example.*

§ IV. *To find the* Plain's Declination.

Having found the Sun's *Azimuth* from the *South* part of the Meridian (for that is the most Convenient) then by comparing the *Azimuth* and the *Horizontal Distance* together, you may find the *Plain's Declination* by these following *Rules*.

Rule 1. When you make your Observation of the Sun's *Horizontal Distance*, mark whether the Shadow of the *Thred* do fall between the *South*, and that side of the *Quadrant* which is Perpendicular to the *Plain*: For,

1. If the *Shadow* fall between them, then the *Horizontal Distance* and the Sun's *Azimuth* added together, do make the *Declination* of the *Plain*; and in this case, the *Declination* is upon the same *Coast*, whereon the Sun is; *i. e.* if the Sun be *Eastward* of the *South*, the *Plain* declines *Eastward*: If *Westward*, the *Plain* declines *Westward*.

2. If the Shadow fall not between the *South*, and that side of the *Quadrant* which is Perpendicular to the *Plain*; then the *Difference* between the *Horizontal Distance* and the Sun's *Azimuth* from the *South*, is the *Declination* of the *Plain*: And in this case, if the *Azimuth* be the *greater* of the two, then the *Plain* declineth to the *same Coast* whereon the Sun is: Otherwise, if the *Horizontal Distance* be the *greater* of the two, then the *Plain* declineth to the *Coast*, contrary to that on which the Sun was, at the time of Observation.

Rule 2. Note here farther, that a *Plain Declination* thus found, is always accounted from the *South*; and that all *Declinations* are numbred from either the *South* or *North*, towards either *East* or *West*, and must never exceed 90 degrees: Wherefore,

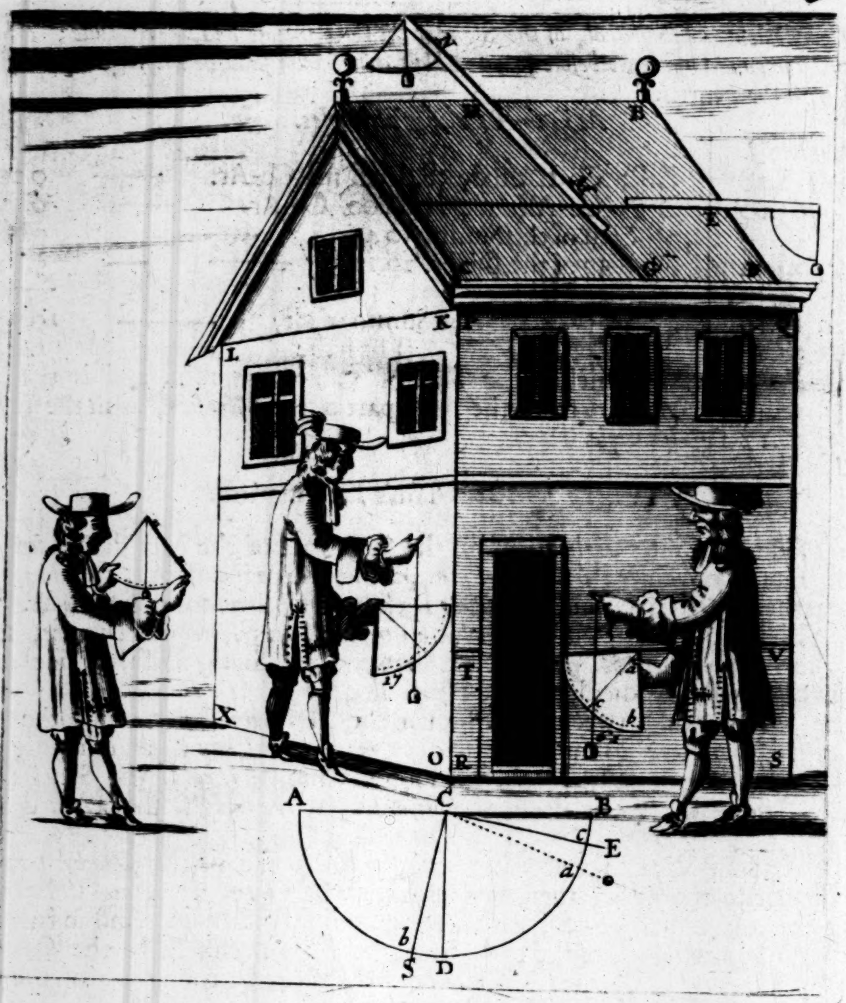
1. If the number of Degrees of *Declination* do exceed 90 deg. take the residue of that number to 180 deg. and that shall be the *Declination* of the *Plain* from the *North*, towards that *Coast* whereon the Sun was: But,

2. If the number of degrees of *Declination* do exceed 180 deg. then the excess above 180 deg. are the degrees of the *Plain's Declination* from the *North*, towards that *Coast* which is *contrary* to that whereon the Sun was at the time of Observation.

Example

Example in the formentioned Observation.

Upon a piece of Paper, or Paistboard, draw a Line, as A C B, representing the *Dial Plain*, and upon C, with 60 deg. of your *Scale* of *Chords*, describe the Semicircle A D B; then when the side of your *Quadrant* C B was applied to the *Plain*, the side C D was Perpendicular thereto, and holding up your *Thred* and *Plummet*, you found the *shadow* of the *Thred* to pass through 70 deg. of your *Quadrant*, wherefore take 70 deg. out of your *Chords*, and set them from D to *a*, and draw the line C *a* ☉, for the line of the Sun's *Azimuth* from the Perpendicular line of the *Plain*, at the time of Observation. Then (at the same time taking the Sun's *Altitude*) you hereby, by the III. Sect. hereof, find the Sun's *Azimuth* to be 76 deg. 30 min. from the *South*; therefore take 76 deg. 30 min. and set them from *a* to *b*, and draw the Line C *b* S; so shall the Line C *b* S be the *Meridian line*, and *b* the *South*



Point of the *Horizon*: Now, if you take 90 deg. and set them from *b* to *c*, and draw the Line C *c* E, that point *c* shall be the *East* point of the *Horizon*, and the Line C *c* E, the Line of *East* and *West*: The *Scheme* being thus drawn, you may see that the Line of *shadow* does not fall between the Line C *b* S the *South*, and the Perpendicular C D; wherefore, (by the second part of the first *Rule* before going) the *difference* between the *Azimuth* and *Distance* (which is 6 deg. 30 min.) is the *Declination* of the *Plain*: And also, because (by the same second part of the same *Rule*) because the *Azimuth* is the *greater* of the two, the *Plain declines* to the same *Coast* to that whereon the Sun was at the time of the *Observation*, which is *Eastward*, because the *Observation* was in the Forenoon: So that this *Plain* must be called, *An upright Plain, declining from the* South, *towards the East, 6 deg. 30 min.* And so it appears by the *Scheme*, where you see, that the Line A C B, representing the *Dial Plain*,

Plain beholds S the *South*, and E the *East* Points of the *Horizon*; the *North* and *West* Points being on the back part thereof, as appears by the foregoing Figure.

§ V. *To find the* Reclination *of a* Plain.

IN the foregoing Figure, let A B C D, being the Roof of the Building P L R X, represent a *Reclining Plain*. First, draw thereon an *Horizontal Line*, which may be done by an ordinary *Level*; or by applying a *Ruler* to the *Plain*, letting one hold the *Ruler* so to the *Plain*, till you find by the edge of the *Quadrant* applied to the *Ruler*, the Line and Plummet to fall just upon the edge of the *Quadrant*; then draw a Line by the side of the *Ruler*, as E F; and that shall be the *Horizontal Line* of the *Reclining Plain* A B C D.

Secondly, To this *Horizontal Line* E F, draw another Line at Right Angles thereto, as the Line G H; to which Line, apply the side of a *Ruler* M N, and towards that end of the *Ruler* which hangeth over the *Plain*, as N, apply the side of a *Quadrant*, letting the *Thred* and *Plummet* have free liberty to play by the side of the *Quadrant*; and when it resteth, note what degrees of the *Quadrant* the *Thred* resteth upon; for those degrees counted from the side of the *Ruler*, are the quantity of the *Plain's Reclination*. The manner of the work of this *Chapter*, will best appear by the foregoing *Figure*.

CHAP. III.

How to know which Pole, *whether the* North *or the* South, *is to be elevated over any* Dial Plain, *in any Position.*

THE *Stile* of every *Dial*, represents the *Axis* of the *World*, and therefore the two ends thereof must directly respect the two *Poles* of the *World*: And therefore, if the *South Pole* be elevated above any *Dial Plain*, a *Dial* made on the *Back-side* thereof, must have the *North Pole* elevated above it: And to know which *Pole* is to be elevated over any *Plain*, observe these few

General RULES.

1. Upon the *Horizontal Plain*, in *North Latitude*, the *North Pole*; in *South Latitude*, the *South Pole*.

2. Upon all *Erect Plains*, whether *direct* or *declining*; if the *Plain* lie open to the *South*, the *South Pole* is elevated; but if it behold the *North*, the *North Pole* is elevated.

3. Upon direct *East* or *West Plains*, *Reclining*, (how far soever,) the *North Pole* is elevated: And upon the *East* and *West Incliners* opposite to them, the *South Pole*.

4. Over all *North Reclining Plains*, (whether *direct* or *declining*) the *North Pole* is elevated: And over the *Inclining Plains* opposite to them, the *South Pole* is elevated.

5. Over all *South Reclining Plains*, whether *direct* or *declining* (if the *Plain* pass between the *Zenith* and the *Pole*) the *Axis* of the *Stile* must have respect to the *South Pole*: And on the *Inclining Plains* opposite to them, the *North Pole*. But if the *Plain* pass between the *Horizon* and the *Pole*, the *North Pole*; and on the *Incliners* opposite to them, the *South Pole* must be elevated.

CHAP. IV.

Of an Horizontal Projection, *upon which any* Dial Plain *may be described; and all the* Requisites *belonging to any such* Plain, *found out Geometrically, and also by Trigonometrical Calculation.*

FOR the better understanding of what I have hitherto delivered concerning the several sorts of *Plains*, upon which *Dials* may be described: And also how to find in what *position any Plain* is situated, in respect of *Declination* or *Reclination*, or both; I have here inserted a Figure or Scheme, which I shall hereafter call

The Fundamental Diagram.

Which is no other then a Projection of the Sphere upon the *Pain* of the *Horizon* of *London*, whose Latitude is 51 deg. 32 min. upon which I have described every several *Plain* before mentioned; and shall, (when I come to the construction of such or such a *Dial*) shew what Line or Circle upon the *Fundamental Diagram* do represent that *Plain*; and also what *Spherical Triangle*, (or Triangle.) is produced by the intersections of other *Great Circles* of the *Sphere*, with the Line or Circle representing the *Plain*, from whence all the *Requisites*, relating to every *Plain*, may be found by *Trigonometrical Calculation*.

CHAP V.

How to find the distances of the Hour-Lines upon an Horizontal Plain.

THis *Plain* is represented in the *Fundamental Diagram*, by the outward (or *Primitive*) *Circle* thereof, N W S E, wherein Z is the *Zenith*, and *Pole* of the *Plain*; therefore, if a *Ruler* be laid to Z, and to the several Points, 3, 2, 1, 12, 11, 10, &c. where the Hour-Circles do cut the *Plain*, right Lines be drawn, those shall be the true Hour-Lines of an *Horizontal Dial*, for the *Latitude* for which the *Fundamental Diagram* was made; *viz.* for *London*, whose *Latitude* is 51 deg. 32 min. represented by the Arch of the *Meridian* N P.

The Arithmetical or Trigonometrical Calculation.

For the making of an *Horizontal Dial*, there is nothing required to be given, but the *Latitude* of the place for which the *Dial* is made, which is here represented by N P 51 deg. 32 min. Now the *Hour Lines* in the *Fundamental Diagram* meeting altogether in P the *Pole*, do cut the *Primitive Circle* N W S E in unequal parts in the point 1, 2, 3, 11, 10, 9, &c. but make equal *Angles* at the *Pole*; and do constitute several *Right Angled, Spherical Triangles*, as N P 11, in which is given (1) the side P N, 51 deg. 32 min. the *Latitude*: (2) the *Angle* N P 11, 15 deg. the *Æquinoctial* distance for one hour: (3) the *Right Angle* at N, to find the side N 11.

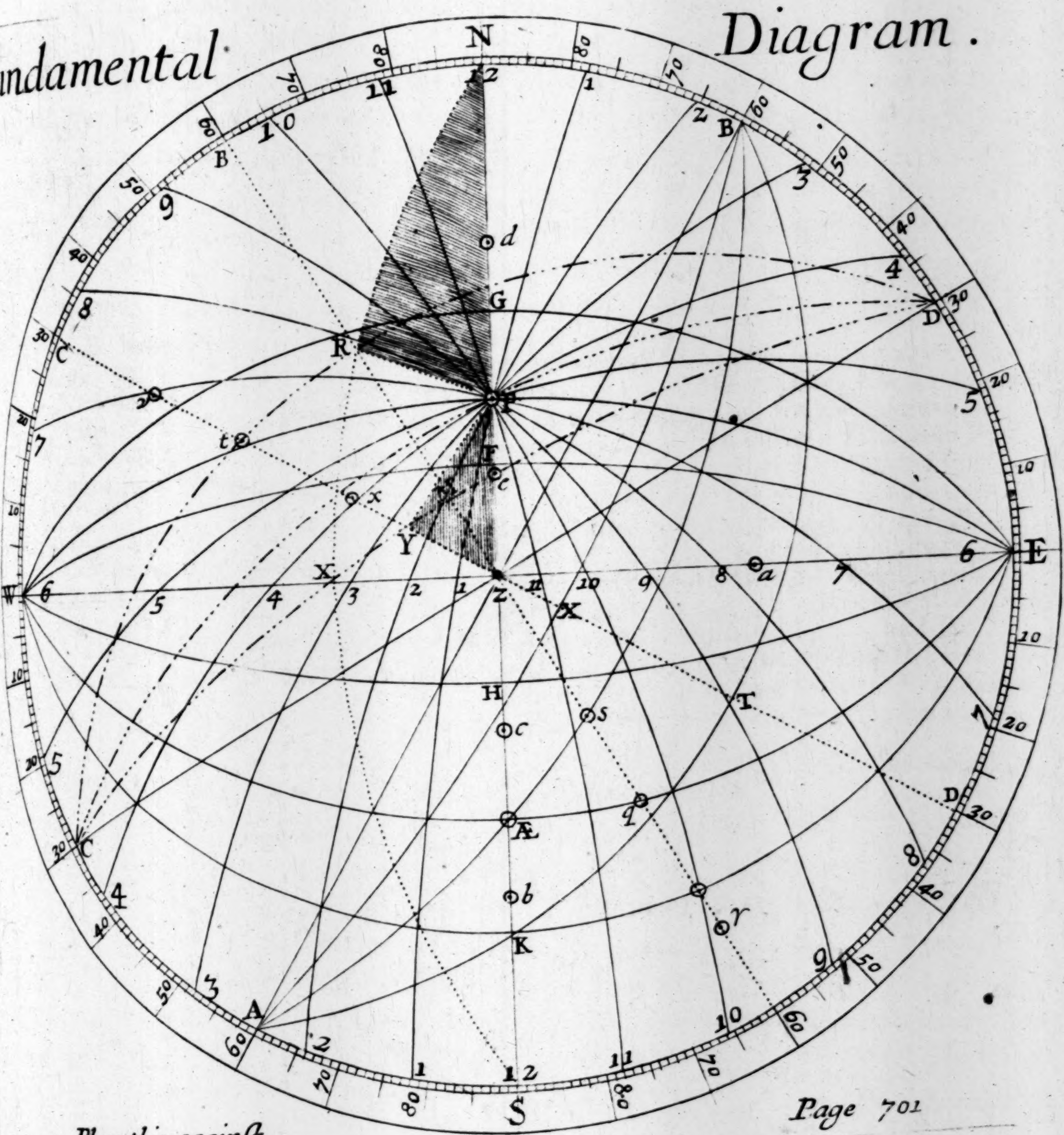
Thus,

As the *Radius*, 90 deg.	10000000
Is to the Sign of the *Latitude* N P 51 deg. 32′	9.893544
So is the Tangent of N P 11, 15 deg. for 1 hour,	9.428052
To the Tangent of the side N 11, 11 deg. 51′.	19.321596

This 11 deg. 51 min. is the true *Hour-distance* of the hours of 11 or 1 a Clock, from the *Meridian* upon the *Dial Plain*:

Where-

Fundamental Diagram.



Place this against *Page 701*

Wherefore, make a *Table*, as this following; In the first Column whereof set the Hours in order from *Noon*, as 11, 10, 9, 8, 7, and 1, 2, 3, 4, 5, 6; and against them in the second Column, set the *Equinoctial distances*, allowing 15 deg. for one hour, 30 for two hours, 45 for three hours, &c. Then by the former *proportion*, the first hours distance being found 11 d. 51 m. set that in the third Column against 11 and 1. Then

Latitude 51 deg. 32 min.					
Hours from Noon.		Equinoctial distances.		True H. distance on the Plain.	
		De.	Mi.	De.	Mi.
12		00	00	00	00
11	1	15	00	11	51
10	2	30	00	24	19
9 and	3	45	00	38	3
8	4	60	00	53	36
7	5	75	00	71	06
6		90	00	90	00

As *Radius*, —— —— 10.000000

Is to the Sign of the *Latitude* N P, 51 d. 32 m. } 9.893544

So is the Tangent of 30 deg. N P 10, 9.761439

To the Tangent of 24 deg. 19 min. 19.654983

Which is the second hours distance upon the *Plain*, namely of 10 and 2 a clock; which set in the third Column of the Table.

The Geometrical Projection of this Dial.

Fig 1.

First, Draw two streight Lines, A B for the *Meridian*, and *Hour Line* of 12, and D F for the hour of 6; crossing each other at right Angles in C, for the Centre of your *Dial*. Upon the Centre C, with 60 deg. of the *Scale of Chords*, describe the Semicircle D E F; then lay your Table before you, and out of your *Scale of Chords* take 11 deg. 51 min, and set them upon the Semicircle both ways from E, for the hours of 11 and 1 a clock: Likewise take 24 deg. 19 min. and set them on both sides from E, for the hours of 10 and 2: Also 38 deg. 3 min. for the hours of 9 and 3; and so of the rest. Through these Points, and the Centre C, draw streight Lines; and they shall be the true *Hour-Lines* upon your *Plain*, from 6 in the *Morning* till 6 at *Night*, which number as you see done in the *Figure*. And for the other four hours, *viz.* 4 and 5 in the *Morning*, and 7 and 8 at *Night*, they are drawn by extending the hours of 4 and 5, and of 7 and 8, through the Centre.

Then for the *Stile* of your *Dial*, take 51 deg. 32 min. from your *Scale*, and set it from E to G, and draw the Line C G for the *Stile* of your *Dial*, which must be placed upright upon the *Hour-Line* of 12; and so is your *Dial* finished, which you may draw into any Form, Square, Round, Oval, or what other Figure you please.

CHAP. VI.

How to find the Distances of the Hour-Lines upon an Erect Direct South *or* North Plain.

THese *Plains* in the *Fundamental Diagram* are represented by the Right Line W Z E, the upper part respecting the *North Pole*, and the lower part respecting the *South*; and the *Hour-Circles* in the *Diagram*, which all meet in P, the *Pole*, do cross the *Plain* W Z E in the Points 6, 5, 4, 3, 2, 1, and 11, 10, 9, 8, 7, 6. The *Poles* of these *Plains* are N or S, to either of which Points if you lay a Ruler, and to the several Points where the *Hour Circles* cross the *Plain*, and make marks upon the outer Peripherie of the *Fundamental Diagram*; those Distances shall be the true Hour-Distances to be set upon the *Dial Plain*; and the Arch of the *Meridian*, P Z, between the *Pole* and the *Plain*, equal to the complement of the *Latitude*, is always the height of the *Stile* or *Pole* above the *Plain*.

The Trigonometrical Calculation.

For the making of these *Dials*, there is nothing requir'd to be known, but the *Latitude* of the place in which the *Dial* is to stand; and that in the *Fundamental Diagram* is represented by the Arch of the *Meridian* N P, 51 deg. 32 min. and the Complement thereof by the Arch P Z, 38 deg. 28 min. which is the *height* of the *Pole* or *Stile* above these *Plains*.

Now the hour Circles in the *Fundamental Diagram* meeting in P, the *Pole*, and intersecting the *Plain* W Z E in the points 5, 4, 3, 2 and 1, do constitute several Right Angled *Spherical Triangles*, as Z P 1, 15 deg. Z P 2, 30 deg. &c. in which Triangle Z P 1, there is given (1) the Right Angle at Z, (2) the Side Z P, the *Complement of the Latitude* of the place, 38 d. 28 m. (3) the Angle 1 P Z, 15 deg. or one hour's distance from the *Meridian*. To find the Side 1 Z, or Z 11, (which are both equi-distant from the *Meridian*,) by this Analogy:

As *Radius* 90 deg.	10.00000
Is to P Z the *Co-Latitude* 38 deg. 28 min.	9.79383
So is the Tangent of 1 P Z, 15 de.	9.42805
To the Tangent of the side 1 Z, 9 deg. 28 min.	19.22188

Which 9 deg. 28 min. is the distance of the hours of 1 and 11 from the *Meridian* N. S. upon the *Plain*, and will be found by the foregoing Proportion to be such as this Table expresseth.

Co-Latitude 38 *deg.* 28 *min.*					
Hours.		*Equinoctial dist.*		*True Ho. distance.*	
		De.	Mi.	De.	Mi.
12		00	00	00	00
1	11	15	00	9	28
2	10	30	00	19	45
3 and	9	45	00	31	53
4	8	60	00	47	8
5	7	75	00	66	42
6		90	00	90	00

The Geometrical Projection of these two Dials.

I. *For the* South.

Fig. II. First, Draw a Perpendicular Line O M, representing the *Meridian* and Hour Line of 12, and another Perpendicular thereunto for the Hour-Line of 6, as N P, intersecting each other at O, the Centre of the Dial.

Secondly, Upon O, describe the Semicircle N Q P, with the Scale of *Chords*, and laying your Table before you, take 9 deg. 28 min. out of your Scale, and set them from Q upon the Semicircle, both ways; for the points of the hours of 11 and 1. Also, take 19 deg. 45 min. and set them always from Q, for the points of the hours of 10 and 2, and so for all the rest, as you find, by your Table, their distances to be from the *Meridian*.

Then Lastly, Take 38 deg. 32 min. the Complement of the *Latitude* from the Scale of *Chords*, and set them from Q to R, and draw the Line O R for the Stile of the Dial, which must stand upon the Hour-Line of 12, and must point *downwards* to the *South Pole*, and so is your Dial finished.

II. *For the* North Dial.

Fig. III. The *North* Dial is the same with the *South*, only the Stile must point upwards towards the *North* Pole, and the Hours about *Midnight*; as 9, 10, 11, at Night, and 1, 2 and 3 in the Morning must be left out; and 4 and 5 in the Morning, and 7 and 8 at Night, must be drawn through the Centre, as in the *Horizontal* Dial; and so is your Dial finished.

CHAP.

CHAP. VII.

How to describe Hour-Lines *upon a Direct* East *or* West *Plain.*

THese Plains are represented in the Fundamental *Diagram* by the Line N Z S, which passeth directly through P, the Pole of the World, and therefore the Pole hath no Elevation above these Plains; and consequently the Dial will have no Centre, but all the Hour Lines will be parallel one to the other: But Dials may be drawn upon such Plains by the following Directions: Figure IV and V.

The Geometrical Construction of these Dials.

Let A B C D be a Dial Plain, upon which you would draw an *East* or *West* Direct Dial.

1. Upon the point C, at the lowermost corner, if it be an *East* Dial, or upon the point D, at the other lowermost Corner, if it be a *West* Dial, with 60 d. of your Line of Chords describe an obscure Arch of a Circle E F; then from the same Line of Chords take 38 deg. 28 min. the Complement of the Latitude of the Place (which is also the Elevation of the Equinoctial above the Horizon) and set that distance upon the Arch from E to F, and draw the Line C F quite through the Plain, which Line shall represent the Equinoctial Circle.

2. That you may the better proportion your Stile to your Plain, and that all the Hours may come on, and be at a convenient distance one from another, assume two points in the Equinoctial Line, one towards the end C, for the hour of 11 in the *East* Dial (or of 1 in the *West* Dial) as the point G, and another towards the other end thereof, for the hour of 6, as the point H; and through these two points, G and H, draw two Lines at right Angles to the Equinoctial Line, for the Hour Lines of XI and VI a Clock.

3. Upon the point G with 60 d. of the Line of Chords describe an obscure Arch of a Circle (below the Equinoctial Line) as I K, setting thereon 15 d. of your Line of Chords, from I to K, and draw the obscure Line G K, extending it till it cut the Hour Line of VI in the point L; so shall the distance L H be the height of the perpendicular Stile proportioned to this Plain.

4. Open your Compasses to 60 d. of your Line of Chords, and setting one foot in the point L; with the other describe an obscure Arch of a Circle M N; between the Hour Line of VI and the Line G L.

5. Divide the Arch M N into five equal parts (which 15 d. of your Line of Chords will do) at the points ⊙⊙⊙⊙⊙, and lay a Ruler from L, to each of these points, ⊙⊙⊙⊙⊙, and the Ruler shall cut the Equinoctial Line C H in the points ****, through which points draw right Lines parallel to the Hour Line of VI, as the Lines VII * VII, VIII * VIII, IX * IX, X * X, and they shall be the true Hour-Lines of an *East* Plain, from Six in the Morning to Eleven before Noon.

6. For the Hour-Lines before VI, namely of IV and V in the Morning, you may put them on by transferring the same Distances upon the Equinoctial Line before VI, as there is between VI, and the Hour-Lines of VII and VIII after VI, and through those Points draw Lines parallel to the Hour Line of VI, and they shall be the Hour Lines of IV and V in the Morning.

7. For the Stile of these *East* or *West* Dials, it may be either a streight Pin or Wire pointed, of the just length of the Line H L, fixed in the point H, or some other part of the Line of VI, perpendicularly to the Plain, which will shew the true hour only by the shadow of the very top thereof, as in the *West* Dial Figure V. —— Or, (which is better) it may be a Plate of Brass or Iron, of the same breadth as is the distance between the Hour Lines of VI and IX upon the Equinoctial, as in the *East* Dial, Figure IV; which Plate must be set perpendicularly upon the Hour Line of VI, which shall shew the hour by the shadow of the upper edge thereof; and so is your Dial finished.

8. If you would insert the halfs and quarters of hours into these Dials, you may easily effect it, by dividing each space between ⊙ and ⊙ on the Arch M N, into four

four equal parts, and so transferring them to the Equinoctial Circle, as you did the whole hours. All which may be plainly seen in Figure V.

In the making of this Dial you have made two Dials, namely, a West Dial as well as an East, for it is the same in all respects as to the Hour-Distances, and Height of the Stile. Only whereas the Arch E F in the East Dials (through which the Equinoctial passeth) was described on the right hand of the Plain, upon the Centre C; in the West Dial it must be described on the left hand, upon the Centre D; and the Hour-Lines of IV, V, VI, VII, VIII, IX, X, and XI in the Forenoon on the East Dial, must be VIII, VII, VI, V, IV, III, II, and I in the Afternoon, on the West Dial; as the Figure IV and V do evidence.

CHAP. VIII.

How to find the Hour-Distances, and the other Requisites *belonging to an Erect* South *or* North *Plain, declining* East *or* West.

LET our *Example* be of an upright *South* Plain, in the Latitude of 51 deg. 32 min. declining *Eastward* 30 deg: And such a Plain is represented in the Fundamental Diagram by the Line C D, the Pole whereof is B. Now the Hour-Circles in the Fundamental Diagram, meeting in P, the Pole, do cut the Plain C D, dividing it into several unequal parts; if a Ruler be laid to B, the Pole of the Plain, and to these several Intersections, the points where the Ruler, so laid, shall cut the outer Circle of the Fundamental Diagram, shall be the Hour-distances, and Lines drawn from Z through those Points, shall be the true Hour-distances upon the Plain: And if you imagine an Arch of a great Circle to pass through P, the Pole of the *World*, and B, the Pole of the Plain, that Circle shall cut the Plain at Right Angles in the point Y; and so there shall be constituted a Right Angled Spherical Triangle, Z P Y, Right Angled at Y.

The Trigonometrical Calculation.

Before you can calculate the Hour-distances for these Plains, there are three *Requisites* to be first enquired; and all of them are to be found in the Right Angled Spherical Triangle P Y Z, right Angled at Y, in which there is given:

1. The side P Z, 38 deg. 28 min. the Complement of the *Latitude*.
2. The Angle P Z Y, the Complement of the Plain's Declination, 60 deg.
3. The Right Angle at Y.

And by help of these the other three Requisites *may be attained; which are,*

1. The Height of the Pole or Stile above the Plain, represented by the side P Y.
2. The *Deflexion*, (or *Substile's* distance from the *Meridian*,) represented by Z Y.
3. The Plain's Difference of *Longitude*, represented by the Angle Y P Z.

I. *For the Height of the* Pole *or* Stile *above the* Plain P Y.

As the *Radius*, 90 deg. ——— ——— ———	10.00000
Is to the Co-Sine of the Latitude P Z, 38 deg. 28 min. ———	9.79383
So is the Co-Sine of the Plain's Declination P Z Y, 60 deg. ———	9.93753
To the Sign of P Y, 32 deg. 36 min. ——— ——— ———	19.73136

Which is the height of the Pole or Stile above the Plain.

II. *For the* Deflexion, *or Substile's Distance from the Meridian* Z Y.

As the *Radius*, 90 deg. ——— ——— ——— ———	10.00000
Is to the Sign of the Plain's Declination, 30 deg. ——— ———	9.69897
So is the Co-Tangent of the Latitude Z P, 38 deg. 28 min. ———	9.90008
To the Tangent of Y Z, 21 deg. 40 min. ——— ——— ———	19.59905

Which is the *Substile's* Distance from the *Meridian*.

III. For

III. *For the Plain's Difference of Longitude*, Y P Z.

As the Co-Sign of the Latitude P Z, 38 deg. 28 min.	9.79383
Is to the *Radius*, ——— ——— ———	10.00000
So is the Sign of the Deflexion Y Z, 21 deg. 40 min.	19.56736
To the Sign of Y P Z, 36 deg 25 min.	9.77353

Which is the Plain's Difference of Longitude.

From the Plain's Difference of Longitude thus found, by allowing 15 deg. of the Equinoctial for one hour, and 1 deg. for 4 min. of time; it will follow, that the Substile will fall between the Second and Third hours from the *Meridian*; that is, between the hours of 2 and 3 in the Afternoon, if the Plain decline *Westward*; or between 9 and 10 in the Forenoon, if the Plain decline *Eastward*.

For because the Plain's Difference of Longitude falls between 30 d. and 45 d. (which is the Second and Third Hour's Equinoctial Distance) there will be two Compleat Hours, and 6 deg. 25 min. more: Wherefore prepare a Table of the Hours fit for the Plain, as is here done in the done in the first Column of the Table.

Then against XII, set the Plain's Difference of Longitude 36 deg. 25 min. from which subtract 15 deg. and there will remain 21 deg. 25 min. which set against XI and I; and from 21 deg. 25 min. subtract 15 deg. and there will remain 6 deg. 25 min. which set against X and II, and (because it is less than 15 deg.) write the word Substile over it, and subtract it from 15 deg. and and the remainder 8 deg. 35 min. set over Substile, and against the Hours of IX and III; to this 8 deg 35 min. by the continual addition of 15 deg. you shall have such Equinoctial Hour-distances, as in the Table: Which Table thus prepared, the next thing will be to find the true Hour distances upon the Plain from the Substiles.

A Table of the Hour-Distances for a South Dial, declining 30 deg. East *or* West.

	D.M.
Latitude of the place,	51.32
Deflexion,	21.40
Stile's Height,	32.36
Difference of Longitude,	36.25

Hours for the East,	*Hours for the* West,	*Equinoctial Ho. Distances.* De.	Mi.	*The true Ho. Distances on the Plain from the Substile.* Deg.	Min.
IV	VIII	83	35	78	12
V	VII	68	35	53	57
VI		53	35	36	08
VII	V	38	35	23	16
VIII	IV	23	35	13	14
IX	III	8	35	4	36
		Substile			
X	II	6	25	3	28
XI	I	21	25	11	56
XII		36	25	21	40
I	XI	51	25	34	03
II	X	66	25	51	00
III	IX	81	25	74	21

IV. *To find the true Hour-distance upon the Plain from the Substile.*

For which this is the Proportion.

As the *Radius* 90 deg. ——— ——— ———	10.00000
Is to the Sign of the Stile's Height, 32 deg. 36 min.	9.73140
So is the Tangent of the several Equinoctial distances from the Substile, as 6 deg. 25 min.	9.05101
To the Tangent of 3 deg 28 min.	18.78241

Which is the distance of the Hour-Lines of 10 or 2 a Clock from the Substile.

So again,

As the *Radius* 90 deg. ——— ——— ———	10.00000
Is to the Sign of the Stile's Height 32 deg. 36 min.	9.73140
So is the Tangent of the next Equinoctial distance, 21 deg. 25 min.	9.59394
To the Tangent of 11 deg. 56 min.	19.32534

Which

Which 11 deg 56 min. is the diſtance of the hour-lines of 11 and 1 of the Clock from the Subſtile.

And according to the Method here preſcribed, you muſt deal with all the *Equinoctial Diſtances* in the Second Column of the Table; ſo ſhall you find the true Hour-diſtances to be ſuch as are exhibited in the third Column from the Subſtile.

The Geometrical Projection of theſe Dials.

Fig. VI. Draw a Right Line C D, for the *Meridian* or Hour-line XII, and towards the top thereof croſs it with another Line A B, at Right Angles in C; ſo ſhall C be the Centre of the Dial, upon which, with 60 deg. of your *Chords*, deſcribe the Semicircle A H B; then laying your Table before you, take 21 deg. 40 min. (the Deflection, or Subſtile's Diſtance from the *Meridian*,) and ſet it upon the Semicircle from H to E, if the Plain decline *Weſtward*, as in this Example it doth; or towards K, if the Plain had declined *Eaſtward*, and draw the Line C E, for the Subſtilar Line of your Dial: Alſo take 32 deg. 36 min. from your Scale of Chords, and ſet them from E to F, and draw the Line C F for the *Axis*, or Stile of your Dial.

This done, Out of your Table take the reſpective Hour-diſtances from a Scale of Chords, and ſet them off upon the Semicircle from E; ſo Lines drawn from C, the Centre of the Dial through thoſe Points, ſhall be the true Hour-Lines proper for the Declining Plain.

Now in the making of this *South* Dial, declining *Weſtward* 30 deg. you have made four Dials: Namely,

A *South* declining *Weſt*	30 deg.
A *South* declining *Eaſt*	30 deg.
A *North* declining *Eaſt*	30 deg.
A *North* declining *Weſt*	30 deg.

Only by changing the names of the Hours, and placing the Subſtile on the contrary ſide of the Line of XII, for the *South* declining *Eaſt* Dial. Then if you turn theſe two Dials upſide down, you have two *North* declining Dials, one *Eaſt*, the other *Weſt* 30 deg. the Stile, Subſtile, and Hour-diſtances being the ſame in all four *Plains*; but in the two *North* decliners, the Stile muſt point upwards, towards the *North* Pole, as the *South* decliners do downwards, towords the *South* Pole; and to remove all doubts concerning this matter (which is very material for a Dialliſt to be perfect in) I have in Figure VI. drawn the Hour-Lines of the two *South* Decliners through the Centres, and they produce the two *North* decliners, only the hours before 4 in the *Morning*, and after 8 at *Night* are omitted, the Sun being then under our *Horizon*; ſo that XII, being drawn through the Centre, will be XII at *Midnight*; but no more of this, for the ſight of the Figure will work more upon the Fancy, than a whole Chapter of Information.

CHAP. IX.

How to draw Hour Lines upon a South *or* North Plain, *which declines* many Degrees *towards the* Eaſt *or* Weſt.

Fig. VII. If a Plain ſhall be found to decline many Degrees from the *North* or *South* towards either *Eaſt* or *Weſt*; as above 60 deg. although the *Requiſites* may be found, and the Dial made in all reſpects as the former Dial was, in the laſt *Chapter*, yet by reaſon that the Pole of the World will have but ſmall Elevation above ſuch a Plain, the Hour-Lines will fall ſo cloſe one to another, that there will be no competent diſtance between them, till they be extended very far from the Centre: And therefore, it was the way of the Ancients, to draw the Dial upon a large Floor, and extend the Hour-Lines, Stile, and Subſtile, to a great length, that ſo the Hour-Lines might be of a convenient diſtance; and then to cut the Dial off, Stile and all, and ſo transfer it to the Plain. But this being too *Mechanical*, I will here ſhew a more Artificial way how to draw ſuch a Dial *Geometrically*, by help of a Line of Chords only, having no regard to the Centre of the Dial. But,

1. By

I. *By* Trigonometrical *Calculation.*

You must find the *Requisites*, Namely, (1.) *The Height of the* Pole, *or Stile, above the* Plain. (2.) *The Distance of the Substile from the* Meridian. (3.) *The* Plain's *Difference of* Longitude. All which may be found by the foregoing *Analogies* or *Proportions.*

Suppose therefore an upright Plain, in the Latitude of 51 deg. 32 min. should decline from the *South Eastward* 85 deg.

I. *For the* Stile's *Height.*

As the *Radius* 90 deg. ——————————————— 10—00000

Is to the Co-Sine of the Latitude 38 deg. 28 min. ——————— 9—79384
So is the Co-Sine of the Plain's Declination 5 deg. ——————— 8—94029

To the Sine of 3 deg. 6 min. the Height of the Pole or Stile ——— x8—73413

II. *For the* Substile's *Distance from the* Meridian.

As the *Radius* 90 deg. ——————————————— 10—00000

To the Sine of the Declination 85 deg. ——————————— 9—99834
So is the Co-Tangent of the Latitude 38 deg. 28 min. ————— 9—90008

To the Tangent of 38 deg. 22 min. ——————————— x9—89842
For the *Deflexion*, or the *Substile's* Distance from the *Meridian.*

III. *For the* Plain's *Difference of Longitude*

As the Sine of the Latitude 51 deg. 32 min. ——————————— 9—89374

Is to the *Radius* 90 deg. ——————————————— 10—00000
So is the Tangent of the Declination 85 deg. ——————— 11—05804

To the Tangent of 86 deg. 5 min. ——————————— 11—16430
Which is the *Plain's* Difference of Longitude.

These *Requisites* being thus found, you may proceed to the making of a Table for the Hour Distances, in all respects as in the last Chapter: By, first, setting down the Hours proper for the Plain in Order, as in this Table: And against XII set the Plain's Difference of Longitude 86 deg. 5 min. from which subtract 15 deg. and there will remain 71 deg. 5 min. which set against XI and I. Also from 71 deg. 5 min. subtract 15 deg. the remainer will be 56 deg. 5 min. which set against X and II; and so by the continual subtraction of 15 deg. you shall find 11 deg. 9 min. to stand against VII and V, under which write *The Substile's Place*, and then 11 deg 5 min. being subtracted from 15 deg. there will remain 3 deg. 55 min. which set under *The Substile's Place*, against VI; and then by the continual addition of 15 deg. thereto, you shall have such Equinoctial Distances, as the second Column of the Table affordeth: And then for the true Hour-distances upon the Plain, say,

As the *Radius* 90 deg. ——————————————— 10—00000

To the Sine of the Stile's Height 3 deg. 6 min. ——————— 8—73302
So is the Tangent of 86 deg. 5 min. the Equinoctial Distance of XII. ——— 11—16453

To the Tangent of 33 deg. 23 min. ——————————— x9—89755
Which is the Distance of XII a Clock from the Substile upon the Plain: And so proceeding with the rest of the Equinoctial Distances, you shall exhibit such Numbers as the Third Column affordeth.

	D.	M.
South Declin. West	85	00
Distance Substile and Meridian	39	22
Height of the Stile	3	06
Plain's difference of Longitude	86	05

Hours. East.	Hours. West.	Equinoctial Distances. D.	M	Hour-Dist. on the Plain D.	M.
XII		86	5	38	23
XI	I	71	5	8	58
X	II	56	5	4	36
IX	III	41	5	2	42
VIII	IV	26	5	1	31
VII	V	11	5	0	36
The Substil'es Place.					
VI		3	55	0	13
V	VII	18	55	1	4
IV	VIII	33	55	2	6

By this Table you may see that the Hour-distances about the Substile (and indeed all the rest, except the extream Hour of XII) do fall so near together, that without an infinite extention of them, there will be no competent Distance between Hour-line and Hour-line; wherefore, laying aside your Table, proceed to make your Dial Geometrically, according to these following Directions.

The Geometrical Projection of this (or the like) Dial.

Fig. VIII. 1. Draw a right Line A B, perpendicular to one side of your Plain, and towards the right hand, because the Plain declineth *Eastward*; and with 60 deg. of your Line of Chords, describe an obscure Arch of a Circle C D E, and upon it (from C to D) set off 38 deg 23 min. the Substile's Distance from the *Meridian*, and draw the Line A D for the Substile, quite through the Plain.

2. Out of your Line of Chords take 3 deg. 6 min. the Height of the Stile, and set them upon the former Arch from D to E, and draw the Line A E for the Stile.

3. Now (because the Stile is but of small Elevation, *viz.* but 3 deg. 6 min.) draw another Line (as G H) parallel to the Line of the Stile A E, at such convenient distance as you shall think fit; which shall be your Augmented Stile.

4. Assume any two Points in the Substilar-Line A D, at some convenient distance each from other, as R and S, and through those two Points draw two infinite right Lines, both of them at right Angles to the Substilar-Line A D, as the Lines Z Z, and X X.

5. From the Point R, with your Compasses, take the nearest distance to the new Augmented Stile G H, and set that distance upon the Substilar-Line from R to K. Also, from the Point S, take the nearest distance to the new Augmented Stile G H, and set that distance also upon the Substilar-Line from S to L.

6. Upon these two Points K and L, with 60 deg. of the Line of Chords, describe two Semicircles, and in either of them set off 86 deg. 5 min. the Plain's Difference of Longitude; as from R to M, and also from S to M; both of them on the same side of the Substilar-Line, on which the first perpendicular Line A B was drawn.

7. Divide either of the Semicircles last drawn into 12 equal parts, beginning at the Point M, as the Points ⊙⊙⊙, &c. which 15 deg. of the Line of Chords will effect.

8. Lay a Ruler to the Point L, and the respective Points ⊙⊙⊙, &c. in the Semicircle, and the Ruler will cut the Line XX in the Points ∗∗∗, &c. Also lay a Ruler to K, and the several Points ⊙⊙⊙, &c. and the Ruler will cut the Line ZZ in the several Points ∗∗∗, &c.

Lastly, Lines drawn from the first Point ∗ in the Line Z Z, to the first Point ∗ in the other Line X X, (which the Substilar-Line will direct you how to doe,) those Lines so drawn shall be the true Hour-Lines proper for the Plain, and will appear as in the Figure, and be at a competent distance one from another, without having any relation at all to the Centre.

Now in the making of this Dial you have made four Dials, *viz.*

A { South declining West, South declining East, North declining West, North declining East } 85 degrees,

only by changing of the names of the Hours, and placing the Stile on the contrary

side

side of the Line A B, for the South declining East. And by turning the Dial upside downwards, for the two North Decliners; so that the Stiles may point upwards to the North-Pole, and the Hours about Midnight omitted, as in the former North Dial, Figure VI.

CHAP. X.

How to find the Hour-distances, *and the other* Requisites *belonging to a* Direct East *or* West Plain, *which* Reclineth *from the* Zenith *towards the* Horizon.

Suppose a direct *West* Plain, should recline from the *Zenith* towards the *Horizon* 35 deg. Such a Plain is represented in the Fund. Diagram by the Circle N X S, whose Pole is at *a*. Now if a Ruler be laid to *a*, and to the several Points where the Hour-Circles of the Projection do cross the Plain in the Fundamental Diagram, it will cut the Primitive Circle N W S E in several Points, through which if Lines be drawn from Z, they will be the true Hour-Lines of the *East* or *West* Reclining Plain. And if you imagine an Arch of a Great Circle to pass through P the Pole of the World, and *a* the Pole of the Plain, as the Arch P R, you shall have constituted a Right Angled Spherical Triangle N P R, right angled at R.

Now before the Hour-Distances can be found upon these *East* or *West* reclining Plains, there must be three things found, as there were in upright declining Plains, *viz.*

1. The Height of the Stile or Pole above the Plain.
2. The Deflexion, or Substile's Distance from the Meridian.
3. The Plain's Difference of Longitude.

All which may be found by restoring of the foresaid Spherical Triangle N P R, right Angled at R, in which is given,

1. The Side N P, the *Latitude* of the Place 51 d. 32′.
2. The Angle P N R, the Plain's Reclination 35 deg.
3. The Right Angle at R.

And by these things given, the three former *Requisites* may be found.

I. *For the Height of the* Stile *or* Pole *above the Plain* P R.

As the *Radius* 90 deg.	10.
Is to the Sine of the Latitude 51 deg. 32 min. N P	9.89374
So is the Sine of the Plain's Reclination P N R	9.75859
To the Sine of the Stile's Height P R 26 deg. 41 min.	19.65233

II. *For the* Substile's Distance *from the Meridian* R N.

As *Radius* 90 deg.	10.
Is to the Tangent of the Latitude N P, 51 deg. 32 min.	10.09991
So is the Co-Sine of P N R, the Reclination, 55 deg.	9.91336
To the Tangent of N R, 45 deg. 52 min.	10.01327

Which is the Deflexion, or Distance of the Substile from the Meridian.

III. *For the Plain's Difference of Longitude* N P R.

As the Sine of the Latitude 51 deg. 32 min.	9.89374
Is to the *Radius* 90 deg.	10.
So is the Sine of the Deflexion N R 45 deg. 52 min.	19.85595
To the Sine of N P R 66 deg. 27 min.	9.96221

Which 66 deg 27 min. is the Plain's Difference of Longitude, N P R.

The three Requisites belonging to this Plain being found, you are to prepare a Table, such as followeth, wherein set the Hours proper for the Plain, in the first Column; namely, from 4 in the Morning till 2 in the Afternoon for the *East*, and from 10 in the Forenoon till 8 at Night for the *West*.

Now the Plain's Difference of Longitude being 66 deg. 27 min. there are contained therein four compleat Equinoctial Hours, and 6 deg. 27 min. over; wherefore, the Substile must stand between the Hours of 4 and 5 in the *East* Dial, and between 7 and 8 in the *West*; as is visible in the Fundamental Diagram by the Arch P R. And therefore between those Hours in your Table write the word Substile, and the 6 deg. 27 m. remaining above four Hours, set over the word Substile in the second Column of the Table against the Hours of 4 and 8, and subtracting 6 deg. 27 min. from 15 deg. the remainder, 8 deg. 33 min. set under the word Substile, against the Hours of 5 and 7. Then by the continual Addition of 15 deg. to these two numbers, you shall find the Equinoctial Distances belonging to each Hour, to be such as are exhibited in this Table following, in the second Column thereof: As 21 deg. 27 min. for 3 and 9; and 23 deg. 33 min. for 6 and 6; and so of the rest.

	D.	M.
West Reclining	35	00
Latitude	51	32
Stile's Height	26	41
Deflexion	45	52
Differ. of Long.	66	27

Fig. VIII.

Hours.		*Equinoctial Distances.* D.	M.	*True Hour Distances.* D.	M.
11	1	81	27	71	29
12		66	27	45	52
1	11	51	27	29	24
2	10	36	27	18	20
3	9	21	27	10	0
4	8	6	27	2	54
The		Sub-		stile.	
5	7	8	33	3	52
6		23	33	11	4
7	5	38	33	19	41
8	4	53	33	31	18
9	3	68	33	48	49
10	2	83	33	75	50

Your Table thus prepared, your next work will be to find the true Hour-Distances upon the Dial-Plain, from the Substilar-Line, all which may be found by this following *Analogy*:

As the *Radius*, 90 deg.	10.00000
Is to the Tangent of 6 deg. 27′ (for 4 and 8)	9.05328
So is the Sine of the Stile's Height P R 26 d. 41′.	9.65233
To the Tangent of 2 deg. 45 min.	18.70561

Which 2 deg. 45 min. is the Distance of the Hour-Lines of 4 or 8 upon the Plain, from the Substile. And by continual working of this Proportion you shall find Numbers answering to every Hour's Distance from the Substile upon the Plain, such as in the last Column of the Table.

The Geometrical Construction of these Dials.

First draw a Right Line S L, for the Horizontal Line of the Plain, which in all these Plains the Meridian and hour-line of 12, must lie towards the end thereof, as at S, (on the Right hand for the *East*, but on the Left hand for the *West* Recliner,) make the Centre, upon which, with 60 deg of your Scale of Chords, describe the Arch A D C N B, upon which, set 45 deg. 52 min. the Deflexion from N to C, and draw S C for the Substilar Line of the Dial: Also, set 26 deg. 41 min. from C to D, and draw S D for the Stile or *Axis*.

This done, have recourse to your Table of Hour-distances, from thence take out the several Degrees and Minutes as you find them in the Third Column, and set them upon the Arch A D C B from D the Substilar Line of your Dial; so shall right Lines drawn from the Centre S, through those Points, be the true Hour-Lines belonging to your Reclining or Inclining *East* or *West* Plains.

For in the making of one of these Dials you have made Four, as in upright declining Plains you did, by only changing the Names of the Hours, and leaving out such as the Sun can never shine upon in the Incliners; all which is visible in the Figure, and needs no words for farther Explanation.

CHAP.

CHAP. XI.

Of South Reclining Plains, and how to draw Hour-Lines *upon them.*

I. *The First Variety, of a* South-Plain *Reclining Equal to the Complement of the Latitude.*

THere are three Varieties of *South Reclining Plains*; for the Plain may so recline, that it may fall just into the Pole, and that is when the Reclination of the Plain is equal to the Complement of the Latitude of the Place; and such a Reclining Plain in the Fundamental Diagram is represented by the Circle W P E, passing through the Pole at P, so that the Pole hath no Elevation over the Plain; and therefore the Dial will have no Centre but all the Hour-lines will be parallel one to the other: And the making of such a Dial is the same with the *East* and *West* erect Dials; only, as the Stile in those Dials stood upon the Hour-line of Six, in these it must stand upon the Hour-line of Twelve: and the Equinoctial Line in those, is the Horizontal Line in this: An *Example* of such a Plain you have in Figure IX. Fig IX.

II. *The Second Variety, of a* South-Plain *Reclining less than the Complement of the Latitude.*

Such Plains as recline from the Zenith less than the Complement of the Latitude, do always fall between the Zenith and the Pole. Suppose therefore in the Latitude of 51 deg. 32 min. a *South* Plain should recline from the Zenith 25 deg. Such a Plain is represented in the Fundamental Diagram by the Circle W F E, whose Pole is at *b*; so that if you lay a Ruler to *b*, and to the several Points where the Hour-Circles in the Fundamental Diagram do cross the Reclining Plain W F E, it shall divide the Periphery of the Fundamental Diagram into 12 unequal Parts, through which, if Lines be drawn from the Centre Z, they shall be the true Hour-lines belonging to the Reclining Plain. Fig. X.

The Trigonometrical Calculation.

In this Plain there is nothing required to be found by Trigonometrical Calculation, but the Hour-distances from the Meridian; and before they can be calculated the Height of the Pole, or Stile, above the Plain, must be known; and that is represented by the Arch of the Meridian P F. Wherefore the Plain falling between the Pole and the Zenith, if you subtract 25 deg. the Plain's Reclination, Z F from Z P, 38 deg. 28 min. there will remain F P, 13 deg. 28 min. for the Height of the Pole or Stile above the Plain; which being known, the Hour-distances may be found by this *Analogy*:

As the *Radius*, 90 deg.	10.00000
Is to the Sine of P F (the Stile's Height) 13 deg. 28 min.	9.42805
So is the Tangent of 15 deg. the Equ. Distance for 11 and 1,	9.36713
To the Tangent of 3 deg. 34 min	18.79518

The Distance of the Hours of 11 and 1 a Clock from the Meridian, or 12 a Clock Hour-line: And so for all the rest of the Hour-distances as they are exhibited in the third Column of this Table.

Stile's Height 13 deg. 28 min.					
Hours.		Equinoct. Distance.		Hour-Distance.	
		D.	M.	D.	M.
12		00	00	00	00
1	11	15	00	3	34
2	10	30	00	7	39
3 and	9	45	00	13	07
4	8	60	00	21	58
5	7	75	00	41	00
6		90	00	90	00

The

The Geometrical Construction of these Dials.

Fig. X. There is no other Geometrical Construction of this and the other following direct Recliners, than in a common Horizontal Dial; for having found the Height of the Stile, and the Hour-distances as in the Table, you have no more to doe, than to describe an Arch of a Circle upon the Centre of the Dial, and set off the Hour-Arches, as you find them in the Table. The Stile is to be elevated upon the 12 a Clock-line, equal to an Angle of 13 deg. 28 min. for this Dial will be an Horizontal Dial in that Latitude. And such a Dial you have in Figure X.

This Dial serves also for a North *Inclining Plain, by drawing the Hour-lines through the Centre, and changing their Names.*

III. *The Third Variety, of a* South-Plain *Reclining more than the Complement of the Latitude.*

Fig. XI. Such Plains as recline from the *Zenith* more than the Complement of the Latitude, do always fall between the Pole and the Horizon.

Suppose therefore, that in the Latitude of 51 deg. 32 min. a *South* Plain should recline from the Zenith 70 deg. and such a Plain is represented in the Fundamental Diagram, by the Circle W G E, whose Pole is at C; so that if you lay a Ruler to c, and to the respective Points where the Hour Circles of the Fundamental Diagram do cut the Dial-Plain W G E, the Ruler so laid will divide the Primitive Circle of the Fundamental Diagram into 12 unequal Parts, through which, if Lines be drawn from the Centre Z, they shall be the true Hour-lines for the Reclining Plain.

The Trigonometrical Calculation.

In this Plain (as in the last beforegoing) there is nothing required to be found by Calculation, but the Hour-Distances upon the Plain: And before they can be found, the Height of the Pole or Stile above the Plain must be known; and that is represented in the Fundamental Diagram, by the Arch of the Meridian P G: wherefore Z G 70 deg. being equal to the Reclination, P Z, the Complement of the Latitude 38 deg. 28 min. taken therefrom, leaveth 31 deg. 32 min. for the Arch P G, equal to the Height of the Pole or Stile above the Plain; which being known, the true Hour-distances from the Meridian may be found by this general *Analogy*.

As the *Radius*, 90 deg.	10.00000
Is to G P (the Height of the Stile) 31 deg. 32 min.	9.71850
So is the Tangent of 15 deg. the Equinoct. Distance for 11 and 1	9.42805
To the Tangent of 7 deg. 59 min.	9.14655

The Distance of the Hour-lines of 11 and 1 a Clock from the Meridian, or 12 a Clock Hour-line. And so you may find all the rest to be such as are in the Third Column of this Table.

Stile's Height 31 deg. 32 min.					
Hours.		*Equinoct. Distances.*		*Hour-Distances.*	
		De.	*Mi.*	*De.*	*Mi.*
12		00	00	00	00
1	11	15	00	7	59
2	10	30	00	16	48
3 and	9	45	00	27	36
4	8	60	00	42	10
5	7	75	00	62	52
6		90	00	90	00

For the Geometrical Construction of this Dial, it is no other than to make an Horizontal Dial for the Latitude of 31 deg. 32 min. which is equal to the Stile's Height of this Dial, and the Work is done; and such a Dial you have in Figure XI.

This Dial also serves for a *North* Inclining Plain opposite thereto, by only changing the Names, and leaving out of the Hours above Midnight.

CHAP.

CHAP. XII.

Of North Reclining Plains, and how to draw Hour-Lines upon them.

I. *The first Variety of a* North *Plain, Reclining equal to the Latitude of the Place.*

AS of *South*, so of *North* Reclining Plains there are three Varieties, for the Plain may so recline, that it may fall just in the Equinoctial Circle, and that is, when the Reclination of the Plain is equal to the *Latitude* of the place: And such a Plain is represented in the Fundamental Diagram, by the Circle W Æ E, whose Pole is at P, the Pole of the *World*; unto which Point P, a Ruler laid, and to the several Intersections of the Hour-Circles in the Fundamental Diagram, with the Plain W Æ E, it will divide the Primitive Circle N W S E into 24 equal Parts, and Lines drawn from Z, (the *Zenith*) shall be the true Hour-Lines of a *Plain*, whose *Reclination* is equal to the Latitude of the place: So that to make such a Dial, is no more but to describe a Circle, and divide it into 24 equal Parts, and through those draw right Lines, so many as the longest day in the Latitude wherein the Dial is made doth contain hours. Fig. XII.

For the *Stile* of this Dial, it is represented in the Fundamental Diagram by the Arch of the Meridian P Æ; the Arch Z Æ being equal to the Latitude 51 deg. 32 min. and Z P equal to the Complement thereof, 38 deg. 28 min. which added together, make 90 deg. so that the Stile is no other, than a streight Pin or Wyre, set perpendicularly up in the Centre: And such a Dial you have described in Figure XII.

And in making this Dial, you have made two Dials *viz.* a *South* Inclining Dial also; the *North* (or upper) face whereof being serviceable only from the 10th or 11th of *March*, till the 12 or 13th of *September*, during which time, the Sun hath *North* Declination; and the inclining (or under) face all the time that the Sun hath *South* Declination, namely, from *September* till *March*.

II. *The second Variety of a* North *Plain, Reclining less than the Latitude.*

If a *North* Plain do recline from the *Zenith* less than the Latitude of the place, it falleth between the *Zenith* and the Equinoctial Circle. Fig. XIII.

Suppose therefore that a *North* Plain should recline from the *Zenith* 25 deg. and such a Plain is represented in the Fundamental Diagram, by the Circle W H E, whose Pole is at *d*: Wherefore, if you lay a Ruler to *d*, and to every of the Intersections of the *Hour-Circles* of the Fundamental Diagram, with the Plain W H E, Lines drawn from Z, through those Points, shall be the true Hour-Lines for such a Reclining Plain.

The Trigonometrical Calculation.

In this Plain there is nothing required to be found by Calculation, but the Hour-distances from the Meridian; and before they can be calculated, the Height of the Pole (or Stile) above the Plain must be known, and that is represented by the *Arch* of the Meridian H P, which is compounded of P Z, the Complement of the Latitude, 38 d. 28 m. and Z H, the Reclination, 25 deg. which two added together, make P H 63 deg. 28 min. for the Height of the Stile or Pole above the Plain; and this being obtained, the Hour-distances may be found by the general Analogy, or Proportion following:

As the *Radius*, 90 deg.	10.00000
Is to P H, the Stile's Height, 63 deg. 28 min.	9.95166
So is the Tangent of 15 deg. the distance of 11 and 1.	9.42805
To 13 deg. 29 min.	19.37971

The distance of 11 and 1 a Clock from the Meridian or 12 a Clock Hour-Line, and so of all the rest, as in the third Column of this Table.

Stile's

Stile's Height 63 deg. 28 min.				
Hours.	Equinoctial Distance.		Hour-distances.	
	Deg.	Min.	De.	Mi.
12	00	00	00	00
1 11	15	00	13	29
2 10	30	00	27	19
3 and 9	45	00	41	49
4 8	60	00	57	10
5 7	75	00	73	20
6	90	00	90	00

The Geometrical Construction of these Dials.

The Hour-distances being calculated as in the Table, you have no more to doe but to make an Horizontal Dial for the Latitude of 63 deg. 28 min. and such is the Dial. Fig. XIII.

This Dial serves also for a *South* Inclining Plain opposite thereto, by changing the Names, and leaving out the Superfluous Hours.

III. *The third Variety of a* North *Plain Reclining more than the Latitude.*

Such Plains as do *recline* more than the Latitude of the place, do always fall between the Equinoctial and the Horizon.

Suppose therefore, that in the Latitude of 51 deg. 32 min. a *North* Plain should recline from the *Zenith* 70 deg. and such a Plain is represented to the eye in the Fundamental Diagram, by the *Circle* W K E, whose Pole is at *e*; so that if you lay a Ruler to *e*, and to the respective Points, where the Hour-Circles in the Fundamental Diagram do cross the Plain W K E, the Ruler so laid will divide the Primitive Circle of the Fundamental Diagram into 12 unequal parts; through which Lines being drawn from the Centre Z, shall be the Hour-Lines proper for the Reclining Plain.

The Trigonometrical Calculation.

In this Plain (as in the rest foregoing) there is nothing to be found by Calculation, but the Hour-distances upon the Plain: And before they can be found, the Height of the Pole or Stile above the Plain must be known, and that is represented in the Fundamental Diagram by the Arch of the Meridian P K. Now from P to Z is 38 deg. 28 min. equal to the Complement of the Latitude, and from Z to K is 70 deg. equal to the Plain's Reclination; which two being added together, do make 108 deg. 28 min. for the Height of the Pole above the Plain, which should be the Height of the Stile; but that cannot be the true Height of the Pole above the Plain, for that can never exceed 90 deg. But this Plain falling between the Equinoctial and the Horizon, must needs have so much less Altitude than 90 deg. as the Reclination is more than the Latitude: Therefore if you add 38 deg. 28 min. P Z, to Z K, the Summ will be 108 deg. 38 min. as before: whose Complement to 180 deg. is 71 deg. 32 min. and that is the true Height of the Pole (or Stile) above the Plain.—Or, if you add Z Æ (the Latitude) 51 deg. 32 min. to Z *e*, the Complement of the Plain's Reclination 20 deg. the Summ of them will be 71 deg. 32 min. for the Height of the Pole (or Stile) above the Plain also: And now the Height of the Stile being by this means attained, the Hour-distances upon the Plain may be calculated by the common *Analogie*:

As the *Radius*, 90 deg.	10.00000
Is to the Sine of the Stile's Height, 71 deg. 32 min. Æ *e*,	8.97704
So is the Tangent of 15 deg.	9.42805
To the Tangent of 14 deg. 16 min. for the Distance of 11 and 1 a clock.	19.40509

And

And so repeating this Work for all the hours, you shall have such distances as are expressed in the third Column of the Table.

The Stile must be erected Perpendicularly upon the Hour-Line of 12, (as in all the other direct *North* or *South* Reclining and Inclining Dials,) making an Angle therewith equal to the Height of the Pole above the Plain; which in this Example is 71 deg. 32 min.

The Geometrical Construction of this Dial is no more than to make a common Horizontal Dial for the Latitude of 71 deg. 32 min. And such a Dial you have in Figure XIV.

And in making of this Dial you have made a *South* Inclining Dial also, by drawing the Hour-Lines through the Centre, changing their Names, and leaving out such as the Sun cannot shine upon.

Stile's Height, 71 d. 32 m.

Hours.		*Equinoctial Dist.*		*Hour-Distances.*	
		De.	Mi.	De.	Mi.
12		00	00	00	00
1	11	15	00	14	16
2	10	3	00	28	43
3	9	45	00	43	30
4	8	60	00	58	41
5	7	75	00	74	14
6		90	00	90	00

CHAP. XIII.

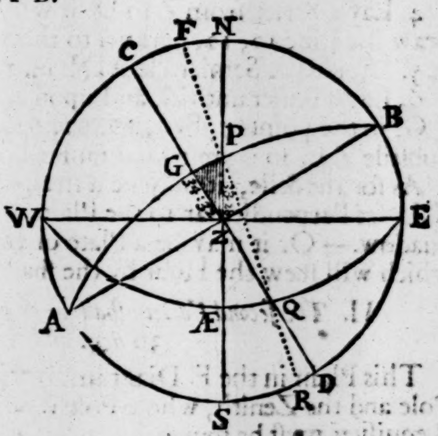
Of South *Declining Reclining Plains, how to find the several Requisites to them belonging, and the Hour-Distances proper to each Plain.*

As there were three Varieties of direct *South* Reclining Plains, so many also are there of *South* Reclinings which do Decline also: For to any Declination, the Plain may be made so to recline; that (1.) it may pass through the Pole of the *World*; or (2.) it may recline so, that it shall fall between the Pole and the Zenith; or (3.) it may recline so, that it shall pass between the Pole and the Horizon.

I. *The First Variety of a* South *Plain, Declining* Eastward 30 *deg. and Reclining from the Zenith* 34 *deg.* 32 *min.*

This Plain in the F. Diagram, is represented by the Circle C P D, whose Pole is at *q*; it passeth directly through P the Pole of the *World*, and therefore hath no Elevation about it; wherefore the Hour-Lines will be all parallel to one another: But before you can draw them, two things must be found.

1. The Distance of the Meridian from the Horizon P B.
2. The Plain's Difference of Longitude Z P Q.



All which may be found by the F. Diagram; but that comes now to be so incumbred with Lines and Letters, that there can conveniently be no more inserted; wherefore for these six Varieties of *South* and *North* Declining Reclining Plains, I will insert in their due places six particular Schemes, wherein shall be described such Circles of the Sphere, as shall represent such Triangles as are necessary for the finding out of the several *Requisites* belonging to each Dial Plain.

In this Diagram, and so in all the other five which follow, the Primitive Circle, W N E S, represents the Horizon of *London*, whose Lat. is 51 deg. 32 min. N Z S the Meridian, W Æ E the Equinoctial, W E the Prime Vertical, P the Pole of the *World*, Z the Zenith: And in this Scheme the Circle A P B represents the Declining Reclining Plain, passing through P the Pole of the World, Q the Pole of the Plain, and P Q R, the Arch of a great Circle, passing through both the Poles, C G D, a Line cutting the Declining Reclining Plain at right Angles in G; by the Intersection of those Circles of the Sphere, there is constituted a right Angled Spherical Triangle Z G P, right Angled at G; by the solution whereof, the two forementioned Requisites may be found.

I. *By Trigonometrical Calculation.*

In the Triangle P G Z, is given (1.) The side G Z 34 d. 32 m. the Plain's Reclination, (2) Z P, 38 d. 28 m. the Complement of the Latitude. (3.) The Angle G Z P 30 d. the Plain's Declination, to find G P.

As the *Radius*, Sine 90. Z G P	10.00000
Is to the Sine of P Z, the Co-Latitude 38 deg. 28 min.	9.79383
So is the Sine of P Z G, the Declination 30 deg.	9.69897
To the Sine of P G 18 deg. 7 min.	19.49280

Whose Compl. 71 d. 53 m. is equal to P B, the Dist. of the *Meridian* from the *Horizon*.

2. For the Plain's *Difference of Longitude* Z P Q. An Arch of a great Circle being drawn through P the Pole of the World, and Q the Pole of the Plain; constitutes the Oblique △ P Z Q; the Angle Z P Q being the Plain's Difference of Longitude, and may be found by resolving the Triangle Z P G, in which is given (1.) Z P 38 d. 28 m. (2.) Z G the Reclination 34 d. 32 m. To find the Angle Z P G.

As the Sine of Z P, 38 deg. 28 min. the Co-Latitude	9.79383
Is to *Radius* 90 deg. Z G P	10.
So is the Sine of Z G the Reclination 34 deg. 32 min.	19.75349
To the Sine of Z P G, 65 deg. 41 min.	9.95966

Whose Compl. to 90 d. is 24 d. 19 m. for the Angle Q P Z, the Plain's *Diff. of Longitude.*

II. By *Spherical Projection.*

The Distance of the Meridian from the Horizon is represented in the Scheme by the Arch of the Plain A P B, and may thus be found;

Lay a Ruler from Q, the Pole of the Plain, to P, the Pole of the World, and it will cut the Primitive Circle near O, at 71 deg. 53 min. distant from B, and that is the *Distance* of the *Meridian* from the *Horizon.*

The Plain's *Difference of Longitude* is represented in the Scheme by the Angle Q P Z, and may be thus found: A Ruler laid from P, the Pole of the World, to Q the Pole of the Plain, will cut the Primitive Circle at R 24 deg. 19 min. from S, and that is the Plain's Difference of Longitude.

III. *The Geometrical Protraction of this Dial.*

Fig. XV. 1. Draw a Line at pleasure, as A Z B, representing the Horizontal Line of the Plain; then considering of what length you would have the Stile to be, answerable to the bigness of your Plain; suppose Z D, take that distance in your Compasses, and setting one foot in Z, with the other describe a Semicircle A C D B, upon which (by help of a Scale of Chords) set 71 deg. 53 min. the distance of the Meridian from the Horizon, from A to C, and draw the Line A C E from the Substile.

2. Take 24 deg. 19 min. the Plain's Difference of Longitude, and set it from C to D.

3. Through the point C, draw a Line F G, Perpendicular to the Substile Z E, and another Line H I, at any distance parallel to F G.

4. Lay a Ruler from Z to D, it will cut the Tangent Line F G, in 12, through which point draw the Line 12, 12, parallel to the Substile Z E, for the Hour-Line of 12.

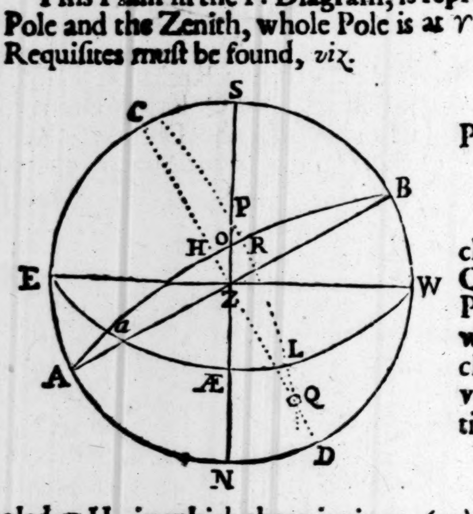
5. Divide the Semicircle A D B into 12 equal parts, at the points * * *, &c. beginning at D.

6. Lay a Ruler unto Z, and upon every of the marks * * *, &c. and it will cut the Line F G, in the points 7, 8, 9, 10, 11, 12, 1, 2; through which points draw Lines parallel to the Substile Z E, so is your Dial finished.

As for the Stile, it may be a streight Pin or Wyre, of the just length of the Line C Z, as K L, set Perpendicular to the Plain upon any part of the Substile, whose point will give the Shadow.— Or it may be a Plate of Brass or Iron, of the same breadth with the Line Z C, which will shew the Hour by the shadow of the side thereof.

II. *The second Variety shall be of a* South *Plain, Declining from the* South Eastward *30 deg. and Reclining from the Zenith 20 deg.*

This Plain in the F. Diagram, is represented by the Circle C M D, and passeth between the Pole and the Zenith, whose Pole is at ♈: And before the Hour-Lines can be described, four Requisites must be found, *viz.*



1. The Dist. of the Merid. from the Horizon O B.
2. The Height of the Pole, (or Stile above the Plain P R.)
3. The Deflexion, or Substile's Dist. from the Merid.
4. The Plain's Difference of Longitude O P R.

In this Scheme, the Circle A H B represents the Declining Reclining Plain, Q the Pole thereof: and P Q R, the Arch of a great Circle passing through P the Pole of the World, and Q the Pole of the Plain, whose Pole is at *a*; and by the Intersection of these Circles, and those of the Sphere, there are constituted several Spherical Triangles, whereby the four forementioned Requisites may be found.

I. *By Trigonometrical Calculation.*

The first is the right Angled △, Z H O, right Angled at H, in which there is given, (1) the Angle H Z O, the Plain's Declination 30 deg. (2) the side H Z, the Plain's Reclination 20 deg. to find the side H O.

As

As the *Radius* Z C 90 deg. —— —— —— 10.00000
Is to the Sine of Z H, 20 deg. the Reclination, —— —— 9.53405
So is the Tangent of C S, 30 deg. the Declination, —— —— 9.76144
To the Tangent of H O, 11 deg. 10 min. —— —— 19.29549

Whose Complement 78 deg. 50 min. is O B, the distance of the Meridian from the Horizon.

In the same Triangle H Z O, you have given, (1) the Angle H Z O 30 deg. the Declination; (2) the side H O, 11 deg. 10 min. to find the side Z O.

As the Sine of H Z O, the Declination 30 deg. —— —— 9.69897
Is to the Sine of the side H O, 11 deg. 10 min. —— —— 9.28705
So is the Sine of Z H O 90 deg. —— —— 10.
To the Sine of Z O, 22 deg. 37 min. —— —— 9.58808
Which taken out of Z P, 38 deg. 28 min. there remains P O, 15 deg. 41 min.

And now we have another vertical and opposite right Angled Spherical Triangle, O R P, the Sines of whose *Hypotenuses* and Perpendiculars, are proportional, use may be made of both the Triangles together, to find P R: For,

As the Sine of the *Hypotenuse* Z O, Co-Ar. —— —— 0.41200
Is to the Sine of the Perpendicular Z H, 20 deg. —— 9.53405
So is the Sine of the *Hypotenuse* P O, 15 deg. 41 min. —— 9.43188
To the Sine of the Perpendicular P R, 13 deg. 49 min. —— —— 19.37793
Which 13 deg. 49 min. is P R, the Height of the Pole, or Stile above the Plain.

Again, In the same Triangle P R O, there is now given, (1) the side P R, 13 deg. 49 min. (2) and P O, 15 deg. 41 min. to find the side O R.

As the Co-Sine of P R, 76 deg. 11 min. —— —— 9.98725
Is to the *Radius*, P R O, 90 deg. —— —— 10.
So is the Co-Sine of P O, 74 deg. 19 min. —— —— 19.98352
To the Co-Sine of O R, 82 deg. 30 min. —— —— 9.99627
Whose Complement 7 deg. 30 min. is the distance of the Deflexion, or Substile from the Meridian.

Lastly, In the same Triangle P R O, there are all the three sides given, and the right Angle at R, to find the Angle O P R, the Plain's Difference of Longitude.

As the Sine of the side P O, 15 deg. 41 min. the Stile's Height, 9.43188
Is to the Sine of the Angle P R O, 90 deg. —— —— 10.
So is the Sine of the side R O, 7 deg. 30 min. —— —— 19.11569
To the Sine of the Angle O P R, 28 deg. 52 min. —— —— 9.68381
Which is the Plain's Difference of Longitude.

The next thing you are to seek, is the Hour-Distances upon the Plain.

The Plain's Difference of Longitude being 28 deg. 52 min. which is but one hour, and 13 deg. 52 min. of the Equinoctial over; wherefore, the Plain declining *Eastward*, the Stile must stand between the Hours of 10 and 11 in the Forenoon: Therefore prepare a Table, and write down the Hours that the Plain is capable to receive; namely, from 5 in the Morning, till 4 in the Afternoon, and between the Hours of 10 and 11, where the Substile must stand, write the word Substile, and under it write 13 deg. 52 min. which subtract from 15 deg. the remainder will be 1 deg. 8 min. which write over Substile. Then to these two Numbers, by the continual addition of 15 deg. (one Equinoctial Hour's-distance) you shall produce such Numbers as are set down in the second Column of the Table. And now to find the true Hour-distances upon the Plain, make use of the accustomed Analogy.

Latitude	51	32
Declination	30	00
Reclination	20	00
Dist. Mer. & Hor.	78	50
Stile's Height	13	49
Deflexion	7	30
Differ. of Longit.	28	52

Hours from Noon.		Equinoctial Distances.		True H. Distances.	
		De.	Mi.	De.	Mi.
5	7	76	8	44	3
	6	61	8	23	25
7	5	46	8	13	57
8	4	31	8	8	12
9	3	16	8	3	57
10	2	1	8	0	16
The		Sub-		stile.	
11	1	13	52	3	22
	12	28	52	7	30
1	11	43	52	12	55
2	10	58	52	21	43
3	9	73	52	39	32
4	8	88	52	85	16

As the *Radius* 90 deg. ——— ——— ———	10.00000
Is to the Sine of the Stile's Height 13 deg. 49 min.	9.37806
So is the Tangent of 76 d. 8 m. the Equinoctial Dist. of 5 or 7 a Clock,	10.60755
To the Tangent of 44 deg. 3 min. the true Distance of the Hours of 5 or 7 upon the Plain from the Substile. }	9.98561

And thus working for every Hour, you shall produce such numbers as are in the third Column of the Table, which with the Meridian, Substile, Stile, or Deflexion, being set upon your Plain, your Dial is finished.

II. *By Spherical Projection.*

I. For O B, a Ruler laid from Q to O, will cut the Primitive Circle at B 7 deg 50 min. from B, and that is the distance of the Meridian from the Horizon.

2. For P R, You must first find the Pole of the great Circle P R Q, which will be at *a*, a Ruler laid from *a*, to P and R, will cut the Primitive Circle in two points, the distance between which will be 13 deg. 49 min. for P R the Stile's Height.

3. For O R, A Ruler laid from Q to O and R, will cut the Primitive Circle in two points, the distance between which will be found to be 7 deg. 30 min. for O R, the Deflexion, or Substile's Distance from the Meridian.

4. For O P R, A Ruler laid from P to L, where the great Circle P R Q crosses the Equinoctial, will cut the Primitive Circle at 28 deg. 52 min. from N, for the Angle O P R, the Plain's Difference of Longitude.

5. For the Hour Distances upon the Plain, a Ruler laid upon ♈, which is the Pole of this Plain C M D, in the Fundamental Diagram, the Intersections of the several Hour Circles in that Diagram with the Plain, will give the true Hour Distances upon the Plain; and will be found such, (either from the Meridian of the Place, or the Meridian of the Plain,) as in the foregoing Table are exhibited.

III. *The Geometrical Protraction of this Dial.*

Fig. XVI. 1. Draw a right Line A C B, and upon it, assume C for the Centre of the Dial, and thereon with 60 deg. of the Chords, describe the Semicircle A F B and (because the Plain declines *Eastward*,) take 78 deg. 50 min. the distance of the Meridian from the Horizon, from your Scale of Chords, and set them from A to E, and draw the Line C E for the Hour-Line of 12: Also take 7 deg. 30 min. of your Chords, and set them from E to D, and draw the pricked Line C D for the Substile. Again, take 13 deg. 49 min. the Stile's Height from your Scale of Chords, and set them (either way) from D, as to F, and draw the Line C F for the Stile or *Axis* of your Dial And lastly, Upon the Semicircle A F B, set off all the Hour-distances from D the Substile, as you find them in the foregoing Table; so Lines being drawn from C the Centre, through those points, shall be the true Hours proper for the declining Plain, and so is your Dial finished, as in Figure XVI.

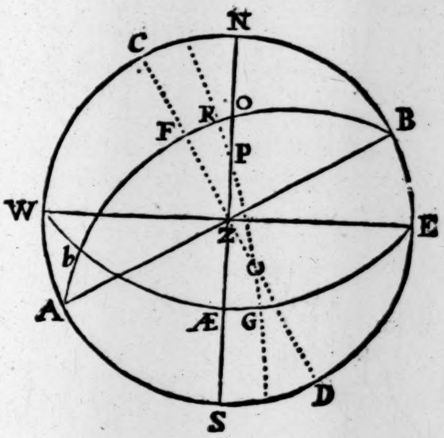
III. *The Third Variety shall be of a* South *Plain, declining* Eastward 30 *deg. and Reclining* 55 *deg.*

Such a Plain is represented in the Fundamental Diagram, by the Circle C R D, which passeth between the Pole and the Horizon, whose Pole is at *s*, and before the Hour-Lines can be drawn, these four Requisites must be obtained. *viz.*

1. The Distance of the Meridian and Horizon O B.
2. The Height of the Pole or Stile above the Plain P R.
3. The Distance of the Substile, and Meridian R O.
4. The Plain's Difference of Longitude R P O.

In

In this Scheme, the Circle A F R O B represents the Declining Reclining Plain, Q the Pole thereof, R P Q an Arch of a great Circle, passing through P the Pole of the World, and Q the Pole of the Plain, whose Pole is at *b*; now by the Interfections of these Circle, with the other great Circles of the Sphere, are constituted several *Spherical Triangles*; by the solution of which, the four forementioned *Requisites* may be found.



I. *By Trigonometrical Calculation.*

1. In the Triangle Z F O, right angled at F, there is given, (1) the side Z F, the Reclination, 55 deg. (2) the Angle Z F O, the Declination 30 deg. to find the side F O.

As the Sine of 90 Z C,	1.000000
Is to the Sine of F Z, the Reclination 55 deg.	9.91336
So is the Tangent of F Z O, the Declination 30 deg.	9.76144
To the Tangent of F O, 25 deg. 9 min.	19.67480

Whose Complement 64 deg. 41 min. is the Ark O B, the distance of the Substile from the Meridian.

2. In the right Angled Triangle B N O, there is given, (1) the side B O, 64 deg. 41 min. the Distance of the Meridian from the Horizon; (2) the Angle N B O 35 deg. the Complement of the Reclination, to find the side N O.

As the Sine of B N O, 90 deg. or *Radius*,	10.00000
Is to the Sine of B O, the dist. of the Meridian and Horizon, 64 d. 41 m.	9.95615
So is the Co-Sine of the Reclination N B O, 35 deg.	9.75859
To the Sine of the side N O, 31 deg. 14 min.	19.71474

Take N O, 31 deg. 41 min. out of N P, 51 deg. 32 min. the remainder will be 20 deg. 18 min. for P O.

3. The Sines of the *Hypotenuses*, and Perpendiculars of the Triangles R O P, and N O B, being proportional, you may deal with both the Triangles together, for the finding of R P: For,

As the Sine of the *Hypotenuse* B O, 64 deg. 41 min. *Co-Ar.*	0.04384
Is to the Sine of the *Hypotenuse* P O, 20 deg. 18 min.	0.54025
So is the Sine of the Perpendicular N B 60 deg.	9.93753
To the Sine of the Perpendicular R P, 19 deg. 25 min.	19.52162

Which 19 deg. 25 min. R P, is the Height of the Pole or Stile above the Plain.

4. In the Triangle R P O, you have given, (1) R P, 19 deg. 25 min. the Distance of the Substile from the Meridian; (2) P O, 20 deg. 18 min. to find R O.

As the Co-Sine of R P, 70 deg. 35 min.	9.97457
Is to the *Radius* P R O, 90 deg.	10.
So is the Co-Sine of P O, 69 deg. 42 min.	19.97215
To the Co-Sine of R O, 83 deg. 58 min.	9.99758

Whose Complement 6 deg. 2 min. is equal to R O, the Distance of the Substile from the Meridian.

5. In the same Triangle R P O, whose three sides are all given, as also the right Angle at R, by which you may find the Angle R P O, equal to Z P Q, the Plain's Difference of Longitude: For,

As the Sine of P O, 20 deg. 18 min.	9.54025
Is to *Radius*, the Angle O R P, 90 deg.	10.
So is the Sine of the side R O, 6 deg. 2 min.	1902163
To the Sine of the Angle R P O, 17 deg. 38 min.	9.48138

Which 17 deg. 38 min. is the Plain's Difference of Longitude.

This

Latitude,				51	32
Declination,				30	00
Reclination,				55	00
Dist. Mer. & Hor.				64	41
Stile's Height,				19	25
Deflexion,				6	02
Difference of Long.				17	38

Hours from Noon.		Equin. Distances.		True Hour Distances.	
		De.	Mi.	Deg.	Min.
5	7	87	22	82	7
6		72	22	46	17
7	5	57	22	27	26
8	4	42	22	16	52
9	3	27	22	9	46
10	2	12	22	4	10
The		Sub-		stile.	
11	1	2	38	0	53
12		17	38	6	2
1	11	32	38	12	1
2	10	47	38	20	1
3	9	62	38	32	42
4	8	77	38	56	35

This 17 deg. 38 min. is but 1 Hour, and 2 deg. 38 min. of the Equinoctial over, it denotes (the Plain declining *Eastward*) that the Stile must stand between the Hours of 10 and 11, a small distance beyond 10: Wherefore prepare your Table, and set down all the Hours the Plain is capable to receive, as from 5 in the Morning, till 4 in the Afternoon; and between the Hours of 10 and 11, write Substile, and under it, the 2 deg. 38 min. remaining, which subtract from 15 deg. and the remainder 12 deg. 22 min. set over Substile, and by the continual addition of 15 deg. to these numbers above and below the word Substile, you shall produce such numbers as those in the Second Column of this Table are.

Now for the Hour-distances upon the Plain, they are found by the usual Canon, *viz.*

As the *Radius* 90 deg.	10.00000
To the Sine of the Stile's Height 19. deg. 25 min.	9.52171
So is the Tang. of 42 d. 22 m. Equi. dist. for 8 and 4 a clock.	9.96002
To the Tangent of 16 d. 52 m. the true dist. of those Hours upon the Plain from the Subst.	19.48173

And so for all the rest of the numbers in the Table: And having found all the Requisites, you may by a Scale of Chords transfer them, and the Hour-distances also from this Table to your Plain.

II. *By the Spherical Projection.*

1. For O B, A Ruler laid from Q, the Pole of the Plain, to O, will cut the Primitive Circle at 64 deg. 41 min. from B, and that is the distance of the Meridian from the Horizon.

2. For P R, A Ruler laid from *b*, the Pole of the great Circle R P Q, to the Points R and P, it will cut the Primitive Circle in two Points, distant one from the other 19 deg. 25 min for P R which is the Height of the Pole above the Plain.

3. For R O, A Ruler laid from Q to R and O, will cut the Primitive Circle in two Points, distant from each other 6 deg. 2 min. for R O, the Deflexion, or Substile's Distance from the Meridian.

4. For the Angle R P O, (or rather the Angle Æ P Q,) a Ruler laid from P to G, where the Arch of the great Circle R P Q crosses the Equinoctial, will cut the Primitive Circle, at 17 deg. 38 min. from S, which is the Plain's Difference of Longitude.

5. For the Hour-distances upon the Plain, A Ruler laid upon *s*, (which is the Pole of this Plain C R D in the Fundamental Diagram,) to the Intersections of the several Hour Circles with that Plain in the Fundamental Diagram, will give upon the Primitive Circle the true Hour-distances upon the Plain, and will be the same as in the foregoing Table.

III. *The Geometrical Protraction of this Dial.*

Towards the bottom of the Plain, (because the Centre must be downwards, and Stile and Hour-lines point upwards,) draw a right Line A C B, making choice of the Point C for the Centre of your Dial; upon which, with 60 deg. of your Chords, describe the Semicircle A D E B: Then from B, the *East* end of the Horizontal Line, set off 64 deg. 41 min. the distance of the Meridian and Horizon from B to I, and draw the Line C I for the Hour line of 12; then take 6 deg. 2 min. and set them from I, Westward (because the Plain declines Eastward) to E, and draw the Line C E for the Substile: Also take 19 deg. 25 min and set them from E, on either side, to D, and draw C D for the Stile of the Dial. And lastly, Upon the Semicircle

circle A D E B, set off all the Hour-distances, as you find them in the foregoing Table, from the Substile at D, so Lines drawn from C the Centre of the Dial, through those Points, shall be the Hour-lines proper to that Plain; and so is your Dial finished, as in Figure XVII.

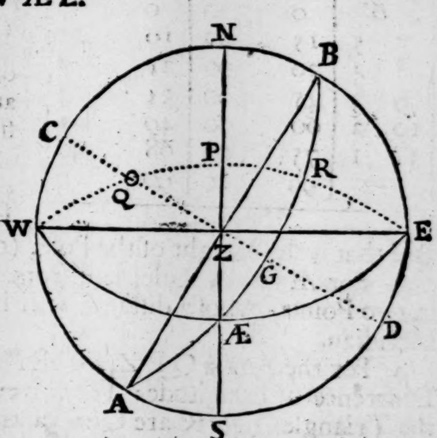
CHAP. XIV.

Of North *Declining Reclining Plains, how to find the several Requisites to them belonging, and the Hour-Distances proper to each Plain.*

OF *North* Declining Reclining Plains, there are the same Varieties as in South Recliners declining, namely, three; for to any Declination, a Reclination may be fitted; so that the Plain may pass by the Intersection of the *Meridian* with the Equinoctial — Or the Reclination may be such, that the Plain may pass between the *Zenith* and the Equinoctial, — Or it may recline so, that the Plain shall pass between the *Æquator* and the Horizon, of all which Examples follow.

I. *The first Variety: Of a* North *Plain Declining Westward* 60 *deg. and Reclining from the Zenith* 32 *deg.* 11 *min.*

In the Fundamental Diagram such a Plain is represented by the Circle A Æ B, the Pole whereof is at *t*; and the Plain it self passeth through Æ, at the Intersection of the Meridian with the Equinoctial Circle W Æ E.



In this Scheme the Circle B G A, represents the Declining Reclining Plain; Q the Pole thereof, W P E an Arch of a great Circle, passing through P the Pole of the World, and Q the Pole of the Plain; which in this Example comes to be the same with the Hour-Circle of 6, W P E, in the Fundamental Diagram, the Pole whereof is at Æ: So that in this Dial, the Hour-line of six, and the Substilar Line will be the same: And before the Hour-distances can be found, two other Requisites must be had, *viz.*

1. The Distance of the Meridian from the Horizon A Æ.

2. The Height of the Pole or Stile above the Plain P R: And for the finding of them, you must resolve the two Spherical Triangles Z G Æ, right Angled at G, and the Quadrantal Triangle P Æ R, made by the intersection of the several great Circles of the Sphere, and those relating to the Declining Plain.

I. *By Trigonometrical Calculation.*

In the right Angled Triangle Z G Æ, there is given (1) Z G, the Plain's Reclination 32 deg. 11 min. (2) the Angle Æ Z G, the Plain's Declination 60 deg. by which you may find Æ G.

As *Radius* 90 deg.	10.00000
To the Tangent of Æ Z G 60 deg. the Declination	10.23856
So is the Sine of Z G 32 deg. 11 min. the Reclination	9.72642
To the Tangent Æ G 42 deg. 42 min.	19.96498

Whose Complement 47 deg. 18 min. is the Distance of the Meridian from the Horizon.

II. For

II. *For* P R, *the Height of the Pole above the Plain.*

In the Quadrantal Triangle P Æ R.

As the Sine of Æ G 42 deg. 42 min.	9.83133
To *Radius* Æ R 90 deg.	10.00000
So is the Tangent of Z G 32 deg. 11 min.	19.79887
To the Tangent of R P 42 deg. 52 min.	9.96754

Which is the Height of the Pole, or Stile above the Plain.

3. and 4. For the other two *Requisites*, the Distance of the Substile from the Meridian R Æ, and the Plain's Difference of Longitude Q P Æ, or Æ P R, they are either of them 90 deg. as is evident in the Projection.

Latitude	15	32
Declination N.	60	00
Reclination	32	11
Dist. Mer. & Hor.	47	18
Stile's Height	42	52
Deflexion	90	00
Difference of Longit.	90	00

Hours from Noon.		Equinoctial Distances. Deg.	Min.	True Hours Distances. Deg.	Min.
6		0	0	0	00
7	5	15	00	10	20
8	4	30	00	21	27
9	3	45	00	34	14
10	2	60	00	49	41
11	1	75	00	68	30
12		90	00	90	0

And for the Hour-distances, they are calculated as the Hour-distances for an Horizontal Dial; wherefore prepare a Table as is here done, setting the Equinoctial Distances against their proper Hours; and then by the general Analogy or Proportion, say,

As *Radius* 90 deg.	10.00000
To the Sine of 42 d. 52 m. the Stile's Height.	9.83270
So is the Tangent of 15 deg. *&c.*	9.42805
To the Tangent of 10 d. 20 m.	19.26075

For the two first Hours from six the Substile, of 5 and 7 on either side; and so for all the rest, as in the Table.

II. *By Spherical Projection.*

1. For A Æ, A Ruler laid from Q, the Pole of the Plain A G B, will cut the Primitive Circle at 47 deg. 18 min. from A, and that is the distance of the Meridian from the Horizon.

2. For P R, A Ruler laid from Æ, the Pole of the great Circle W P E, to R *v*, will cut the Primitive Circle at 42 deg. 52 min. from N; and that is the Height of the Pole, (or Stile) above the Plain.

3. For Æ R: A Ruler laid from Q to R and Æ, will cut the Primitive Circle in two Points, whose distance will be 90 deg. for the Substile's Distance from the Meridian.

4. For the Angle Q P Z, or Æ P R, either of them are 90 deg. for the Plain's Difference of Longitude: For it is evident from the Scheme, that all the sides of the Triangle Q Æ R are Quadrants, and consequently all the Angles right Angles.

5. For the Hour-distances, they may be found by applying a Ruler to *t*, the Pole of the Plain A Æ B in the Fundamental Diagram, and to the several Intersections of the Hour Circles therewith, and it will cut the Primitive Circle at such distances as are set down in the foregoing Table.

In this Dial, the Hour-line of 6 is the Substile; and the Meridian (or Line of 12) is distant from it 90 deg. so that they cut each other at right-Angles, as in all direct Dials they do: And indeed this Dial is no other than an Horizontal Dial, for the Latitude of 42 deg. 52 min. if you call the Hour of 6, the Hour of 12, and so the rest in order.

III. *The Geometrical Protraction of this Dial.*

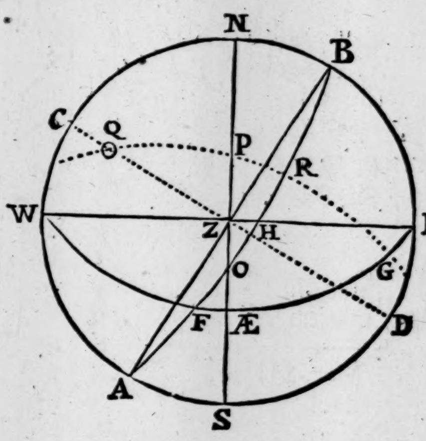
Fig. XVIII. About the middle of the Plain, draw an Horizontal Line A B, and upon any part thereof as C, with 60 deg. of your Chords, describe a Circle A E B D, upon which from A set off 47 deg. 16 min. the Distance of the Meridian from the Horizon, to D, and draw C D for the Hour-line of 12: Also take 90 deg. and set them from D to G, and draw the Line C G for the Substilar and Hour-line of six: Also take 42 deg. 52 min. and set them from G to E, and draw C E for the Stile or *Axis*: Lastly, by help of your Scale of Chords, set upon the Circle E G A D, the

the Hour-distances, as you find them in the Table, both ways from G; through which points, draw Lines from C; and so is your Dial finished, as in Fig. XVIII.

II. *The Second Variety, Of a North Plain, declining Westward 60 deg. and reclining from the Zenith 16 deg.*

This Plain in the Fundamental Diagram, is represented by the Circle B X A, and passeth between the Zenith and the Equinoctial, whose Pole is at *v*. But,

In this Scheme it is represented by A O R B, intersecting the Meridian at O, between the Zenith and the Equinoctial, the Pole whereof is at Q, and Q P R is an Arch of a great Circle, passing through P the Pole of the World, and Q the Pole of the Plain, and cutteth the Plain at right Angles in R; the Pole of which Circle is at F: These Circles, by their Intersections with the Circles of the Sphere, do constitute several Spherical Triangles, whereby the *Requisites* belonging to this Plain may be found, and Four things must be known before the Hours can be drawn, *viz.*



1. The Distance of the Meridian from the Horizon A O.
2. The Height of the Pole or Stile above the Plain P R.
3. The Deflexion, or Distance of the Substile from the Meridian R O.
4. The Plain's Difference of Longitude O P R.

All which may be found as followeth:

I. *By Trigonometrical Calculation.*

1. For A O: In the right Angled Spherical Triangle Z H O, right Angled at H, there is given, (1) the side Z H the Reclination, 16 deg. (2) the Angle Z H O the Declination 60 deg. to find the side A O.

As the *Radius* 90 deg.	10.00000
Is to the Sine of Z H, the Reclination 16 deg.	9.44034
So is the Tangent of H Z O, the Declination 60 deg.	10.23856
To the Tangent of H O, 25 deg. 31 min.	x9.67890

Whose Complement 64 deg. 29 min. is A O, the Distance of the Meridian and Horizon.

2 For P R: In the Triangle P R O, in which there is not yet enough given; wherefore the side P O, in the Triangle H O Z, must first be found, thus:

As the Sine of H Z O, the Declination 60 deg.	9.93753
Is to the *Radius*	10.
So is the Sine of H O, the Arch before found 25 deg. 31 min.	19.63425
To the Sine Z O, 29 deg. 50 min.	9.69672

Unto this Z O, 29 deg. 50 min. add Z P, 38 deg. 28 min. the Summ will be 68 deg. 18 min for the side P O.

And now the two Triangles O Z H, and R O P, being proportional; the side P R may be thus found.

As the Sine of the *Hypotenuse* O Z, 29 deg. 50 min. Co-Ar.	0.30322
Is to the Sine of the *Hypotenuse* O P 68 deg. 18 min.	9.96807
So is the Sine of the Perpendicular H Z, 16 deg.	9.44034
To the Sine of the Perpendicular P R, 30 deg. 59 min.	x9.71163

Which 30 deg. 59 min. is the side P R, the Height of the Pole or Stile above the Plain.

3. For O R: In the two former Triangles; the Sines of their Bases, and Tangents of their Perpendiculars being proportional, OR may be found, thus:

As the Tangent of the Perpendicular Z H, 16 deg. Co-Ar. —— 10.54251
Is to the Tangent of the Perpendicular P R, 30 deg. 59 min. —— 9.77849
So is the Sine of the Base H O, 25 deg. 31 min. —— 9.63425
To the Sine of the Base R O, 64 deg. 26 min. —— 29.95525
Which 64 deg. 26 min. is the Deflexion, or Substile's Distance from the Meridian O R.

4. For the Angle O P R, that may be found in the same Triangle P R O: Thus,

As the Sine of P R, 30 deg. 59 min. —— 9.71163
Is to the *Radius* P R O, 90 deg. —— 10.
So is the Tangent of R O, 64 deg. 26 min. —— 20.32020
To the Tangent of O P R, 76 deg. 10 min. —— 10.60857
Which 76 deg. 10 min. is the Angle O P R, for the Plain's Difference of Longitude

5. For the Hour-distances: In this distance is contained, &c.

Latitude	51	32
Declination	60	00
Reclination	16	00
Dist. Mer. & Hor.	64	29
Stile's Height	30	59
Deflexion	64	26
Difference of Longitude	76	10

Hours from the Substile.		Equinoctial Distances. Deg.	Min.	Hour Distances from the Substile. Deg.	Min.
1	10	88	50	87	44
2	11	73	50	60	37
3	9	58	50	40	24
4	8	43	50	26	18
5	7	28	50	15	49
6	6	13	50	7	13
The		Sub-		stile.	
7	5	1	10	0	36
8	4	16	10	8	29
9	3	31	10	17	18
10	2	46	10	28	12
11	1	61	10	43	5
12	12	76	10	64	26

In this distance is contained five compleat Hours, and 1 deg. 10 min. more, wherefore the Stile must stand between the fifth and sixth Hours from the Meridian. Prepare therefore a Table as is here done, and write down all the Hours, and between the Hours of 5 and 6, or 6 and 7 (which are all one, according as the Plain declines Eastward or Westward) write Substile, and under it, the remainder 1 deg. 10 min. against 7 and 5, which subtract from 15 deg. and there will remain 13 deg. 50 min. which write over Substile against the Hours of 6 and 6. And so by the continual addition of 15 deg. to the numbers next above and below Substile, you shall produce such numbers as this Table affords in the second Column thereof; from which numbers, which are Equinoctial Distances, the true Hour-distances upon the Plain, may be collected by this Proportion.

As *Radius* 90 deg. —— 10.00000
To the Sine of 30 deg. 59 min. the Stile's Height —— 9.71163
So is the Tangent of 88 deg. 50 min. the first Equinoctial distance, —— 11.69112
To the Tangent of 87 deg. 44 min. —— 11.40275
Which is the true Hour-distance of the Hours of 1 and 11, upon the Plain from the Substile; and so doing for all the rest, you shall produce such numbers as the third Column of the Table affordeth, which may be transferred from this Table, by help of a Scale of Chords; and so is your Dial finished.

II. *By Spherical Projection.*

1. For A O; A Ruler laid from Q, the Pole of the Plain to O, the Intersection of the reclining Plain with the Meridian; it will cut the Primitive Circle at 64 deg. 29 min. from A, and that is the distance of the Meridian and Horizon.

2. For P R: A Ruler laid upon F, the Pole of the great Circle Q P R, to P and R, will cut the Primitive Circle in two Points distant from each other 30 deg. 59 min. and that is the Height of the Pole or Stile above the Plain.

3. For

3. For R O: A Ruler laid to Q, and the Points R and O will cut the Primitive Circle in two points distant from each other 64 deg. 26 min. and such is the distance of the Substile from the Meridian.

4. For the Angle O P R: A Ruler laid from P the Pole of the World, to G, where the Arch of the great Circle Q P R crosseth the Equinoctial Circle W Æ E; it will cut the Primitive Circle at 76 deg. 10 min. distant from S; and that gives the Plain's Difference of Longitude.

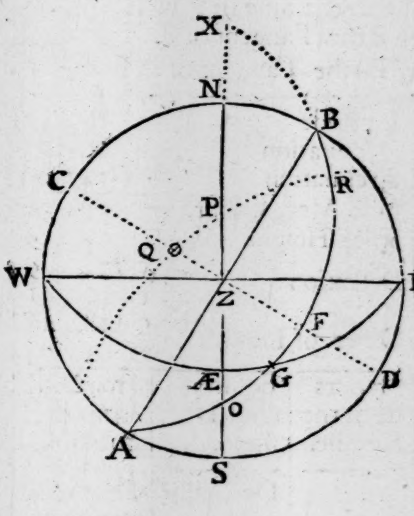
5. For the Hour-distances upon the Plain: A Ruler laid upon *v*, (which is the Pole of this Plain B X A, in the Fundamental Diagram) to the several Intersections, where the Hour Circles there do cut the Reclining Plain, it will upon the Primitive Circle give such Distances as are exhibited in the third Column of the foregoing Table.

III. *The Geometrical Protraction of this Dial.*

About the middle of the Dial Plain, draw an Horizontal Line A B, and towards the end thereof as at C, assume a point for the Centre of the Dial, and upon C describe part of a Circle D E F, upon which, from A, set 64 deg. 29 min. the distance of the Meridian and Horizon, and draw C D for the Hour-line of 12, through the Centre, to D above: Also take 64 deg. 26 min. the distance of the Substile from the Meridian, and set them from D above to E, and draw C E for the Substile. Then take 30 deg. 59 min. the Height of the Pole or Stile above the Plain, and set them from E to F, and draw C F for the *Axis*. Lastly, Take the Hour-distances as you find them in the third Column of the Table, and set them off upon the Circle from E the Substile, and through the several Points draw Lines from C the Centre: So is your Dial finished, as in Figure XIX. Fig. XIX.

III. *The Third Variety of a North Plain, declining Eastward 60 deg. and reclining from the Zenith 54 deg.*

A Plain according to this Declination and Reclination, is represented in the Fundamental Diagram, by the Circle B T A, whose Pole is at *x*. But in this Scheme it is represented by the Arch of a great Circle A O F R B, whose Pole is at Q, and intersects the Meridian at O; the Plain passing between the Horizon and the Equinoctial; and Q P R is the Arch of another great Circle, passing through P the Pole of the World, and Q the Pole of the Plain; by the Intersections of his great Circular Arch, and the Circles of the Sphere are constituted several Spherical Triangles; by the resolution of which, the four *Requisites* belonging to this Plain, before the Hour-lines can be drawn, may be found; and they are



1. The Distance of the Meridian and Horizon A O.
2. The Height of the Pole or Stile above the Plain P R.
3. The Deflexion, or Substile's Distance from the Meridian O R, or R X.
4. The Plain's Difference of Longitude O P R, or X P R.

And these *Requisites* may be found as followeth,

I. *By Trigonometrical Calculation.*

1. For A O: In the Triangle Z F O, there is given Z F, the Reclination Z F, 54 deg. (2) O Z F, the Plain's Declination, with the right Angle at F, to find F O.

As the *Radius* Z F O, 90 deg.	10.00000
Is to the Sine of Z F, the Reclination 54 deg.	9.90795
So is the Tangent of O Z F, the Declination 60 deg.	10.23856
To the Tangent of F O, 54 deg. 29 min.	10.14651

Whose Complement, A O, 35 d. 31 m. is the Distance of the Mer. from the Horizon.

2. For R O: In the Triangle O P R, there is not yet enough given; therefore find the side Z O in the Triangle O Z F. Thus,

As the Sine of O Z F, the Declination, 60 deg. — — — 9.93753
Is to the *Radius* 90 deg. — — — — 10.
So is the Sine of O F, the distance of the Merid. and Horiz. 54 d. 29 m. 19.91059
To the Sine of Z O, 70 deg. 2 min. — — — 9.97306

To this 70 deg. 2 min. add Z P, 38 deg. 28 min. the Summ is 108 deg. 30 min. whose Complement to 180 deg. is P X, 71 deg. 30 min.

Then in the two Triangles, O Z F and O P R, whose *Hypotenuses* and Perpendiculars are proportional.

As the Sine of the *Hypotenuse* O Z, 70 deg. 2 min. Co-Ar. — 0.02694
Is to the Sine of the *Hypotenuse* P X, 71 deg. 30 min. — 9.97695
So is the Sine of the Perpendicular Z F, 54 deg. — 9.90796
To the Sine of the Perpendicular P R, 54 deg. 43 min. — 19.91185

Which 54 deg. 43 min. is the Height of the Pole, or Stile above the Plain.

3. For R O, or its Complement to 180 deg. R X, if you continue the sides O P, and O R to X, you will constitute another Spherical Triangle X B P, in which you are to find the Base X R. Thus:

As the Tangent of the Perpendicular Z F, 54 deg. Co-Ar. 9.86126
Is to the Tangent of the Perpendicular P R, 54 deg 43 min. 10.15021
So is the Sine of the Base F O, 54 deg. 29 min. — — 9.91059
To the Sine of the Base R X, 56 deg. 42 min. — — 29.92206

Which 56 deg. 42 min. is the Deflexion, or Substile's Distance from the North part of the Meridian; whose Complement to 180 deg. is 123 deg. 18 min. its distance from the South part thereof.

4. For the Angle O P R, or its Complement to 180 deg. X P R.

As the Sine of P R the Stile's Height, 54 deg. 43 min. — 9.91184
Is to the Sine of P R X, *Radius* 90 deg. — — 10.
So is the Tangent of R X, the Substile's Distance 56 deg. 42 min. 20.18251
To the Tangent of R P X, 61 deg. 48 min. — 10.27067

Latitude	51	32
Declination	60	00
Reclination	54	00
Dist. Mer. & Hor.	35	31
Stile's Height	54	49
Deflexion	{ 123	19
	{ 56	41
Differ. of Long:	{ 118	13
	{ 61	74

Hours from the Substile.		Equinoctial Distances.		Ho. Dist. from the Substile.	
		Deg.	Min.	Deg.	Min.
11	1	76	47	73	57
12		61	47	50	41
1	11	46	47	40	59
2	10	32	47	26	50
3	9	16	47	13	50
4	8	1	47	1	27
The		Sub-		stile.	
5	7	13	13	10	51
6	6	28	13	23	39
7	5	43	13	37	29
8	4	58	13	52	48
9	3	73	13	69	43
10	2	88	13	87	49

Which is the Plain's Difference of Longitude, R P X being 61 deg. 48 min. is the Angle counted from the North, therefore the Angle O P R, the Complement to 180 deg. is 118 deg. 13 min. the Plain's Difference of Longitude reckon'd from the South.

These things prepared, I proceed to make the Table for the Hour Distances from the Substile, wherein considering that the Angle P, the Plain's Difference of Longitude, is 118 deg. 12 min. reckon'd from the South, whereof 90 deg. is answerable to 6 Hours, and 105 to 7 Hours, and there is yet remaining 13 d. 13 m. it is evident, for the Substile must be drawn between the 7th and 8th Hour from the South part of the Meridian, or between the 4th or 5th Hour, reckoned from the North part.

Wherefore set the Hours down as in the Table, and between the Hours of 4 or 8, and 5 or 7, write Substile, setting the remainder 31 deg. 13 min. over Substile, and by the continual addition of 15 deg. to both these numbers, you shall produce the Equinoctial Distances, as in the Second Column of the Table. And those by the general Canon, will help you to the true Hour-distances upon your Plain. For,

As

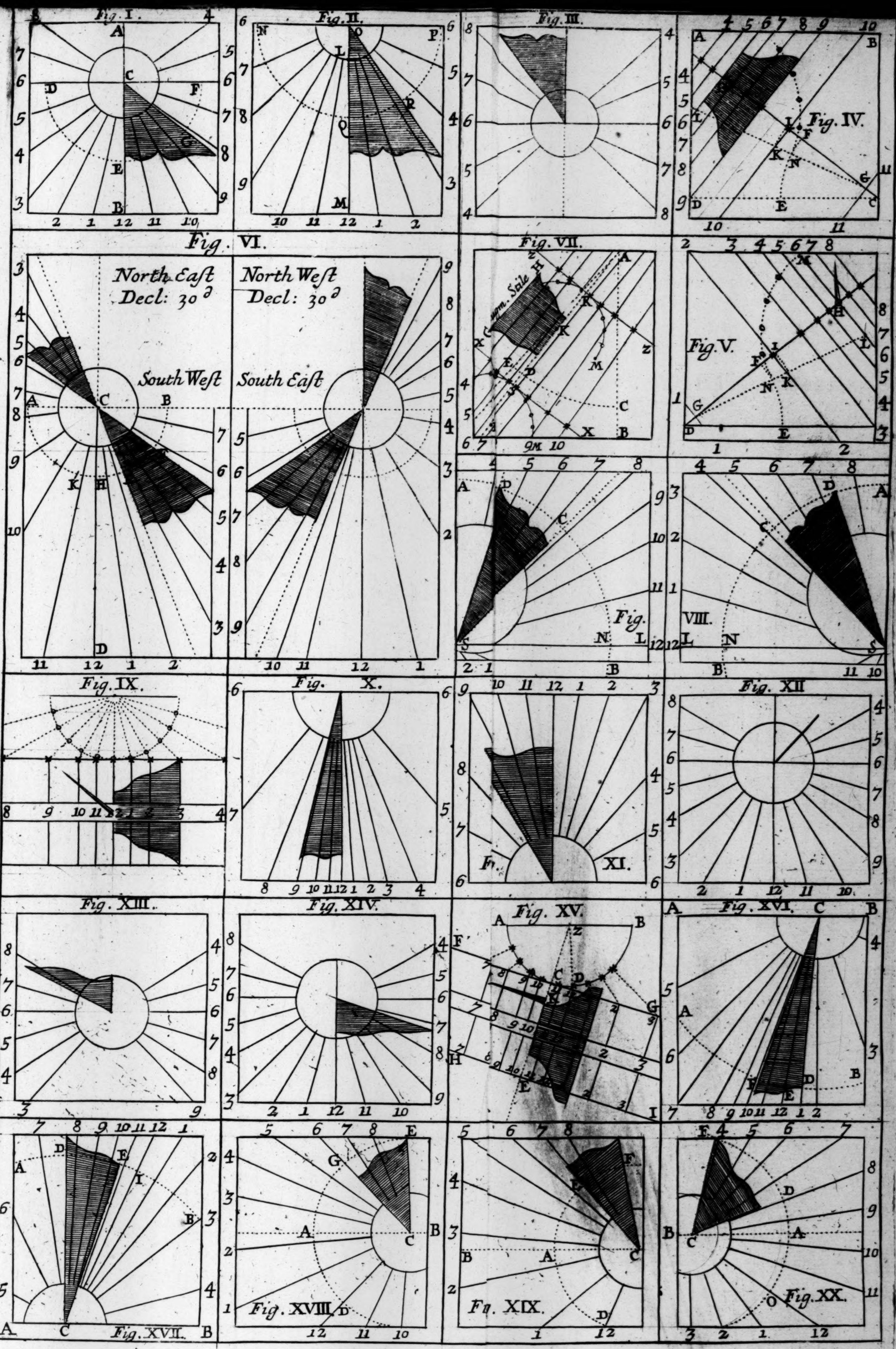


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Figure VI. a

adius 90 deg. — — — — 10.00000
o the Sine of 54 deg. 43 min. the Stile's Height. 9.91185
the Tangent of 28 d. 13 m: the Equinoctial Distance for 6 a Clock, 9.72963
o the Tangent of 23 deg. 39 min. — — 19.64148
ich is the true distance of the 6 a Clock Hour from the Substile of the Dial.

nd thus continuing this proportion through all the Equinoctial Distances, you will he end have such numbers to every Hour as the third Column of the Table sheweth, ch are the true Hour-distances counted from the Substile upon your Plain.

The Meridian, Horizon, Substile, and Hour-distances, may be transferred from this le to the Dial Plain at pleasure, by help of a large Cord and Beam Compasses.

II. *By Spherical Projection.*

. For A O: A Ruler laid from Q, the Pole of the Plain to O; it will cut the mitive Circle at 35 deg. 31 min. from S, which is the distance of the Meridian n the Horizon.

For P R: A Ruler laid from G, the Pole of the Arch of the great Circle R, to the points P and R; it will cut the Primitive Circle in two Points, the ance between which will be 54 deg. 43 min. for the Height of the Pole, or Stile ve the Substile.

. For O R: A Ruler laid from Q, to O and R, will cut the Primitive Circle wo Points, whose distance will contain 123 deg. 18 min. the Substile's Distance n the *South* part of the Meridian; whose Complement to 180 deg. is 56 deg. 42 . its Distance from the *North* part thereof.

. For the Angle O P R: A Ruler laid from P the Pole of the World, to R the rsection of the reclining Plain, with the Equinoctial Circle, will cut the Primi- Circle at 118 deg. 13 min. from S, which is the Plain's Difference of Longitude.

or the Hour-distances upon the Plain: A Ruler laid x, (which is the Pole of this n B T A, in the Fundamental Diagram,) to the several Intersections of the r Circles with the reclining Plain; it will give such Distances upon the Primi- Circle, as are in the third Column of the foregoing Table.

III. *The Geometrical Protraction of this Dial.*

irst, Draw the Horizontal Line B C A, about the middle of the Plain: In any thereof, as at C, place the Centre, and with 60 deg. of the Chords, describe the cle A D F B, and from the West point thereof, set 35 deg. 31 min. the Distance he Meridian from the Horizon, from A to O, and draw the line O C G, for Hour-line of 12. Fig. XX.

econdly, From G, the North part of the Meridian, set the Distance of the Substile n the Meridian from G to D, and draw the Line C D for the Substilar Line of Dial.

Thirdly, From D to F, set 54 deg. 43 min the height of the Stile above the Sub-, and draw the Line C F for the Stile.

astly, For the Hour-distances, they must be taken out of the Table, and by the ords set upon the Circle from D the Substilar; upon which the Stile or Axis C F g erected perpendicularly above the Substile, your Dial is finished, as in Fig. XX.

nd thus have you in this one (and in all the six Varieties of North and South lining Decliners) Dial, (as hath been often before intimated) made Four se- l Dials; *viz.* This for one; and his opposite South declining Easterly 60 deg. inclining to the Horizon 36 deg. (which is the Complement of this Reclinati-) Also, a North Declining Easterly 60 deg. and Reclining 54 deg. And his osite, South Declining Westerly 60 deg. and Inclining to the Horizon 36 deg. by drawing the Hour-Lines, Stile and Substile, quite through the Centre; and ng the Dial up and down, Stile and all; and changing the Figures of the Hours Forenoon or Afternoon; according to the Nature of the Plain; and as Reason it will sufficiently direct; and as is already done in an upright Declining Dial in re VI. and in an East and West Reclining Dial Figure VIII. Figure VI. Fig. VIII.

DIAL-

DIALLING

Geometrical and Instrumental.

PARTS II, and III.

THESE Two Parts I shall unite in one, and that for this Reason; The Geometrical Way may be performed by the Circular Scales of Natural Sines, Tangents, and Chords, set upon the Ruler, whose Construction is shewed in Book 3. Part 2. Page 396. of Spherical Projection, and therefore I shall say nothing of their Construction here; for that the same Scales are inscribed upon the Edges of the Quadrant following, by which I intend to shew how, Instrumentally, to make Dials upon all sorts of Plains. As for the finding of the Situation of any Plain, in respect of Declination, Reclination, or both; I refer you to Book 6. Part I. Chap. 1. and 2. hereof: And therefore the Work of this double Part shall be to shew how to describe Hour-lines, and to find all other Requisites belonging to any Dial-Plain in any Latitude: And that,

I. *Geometrically*, By the Scales inscribed upon the Sides of the Quadrant: And,

II. *Instrumentally*, By the Scales and Circles delineated upon the Superficies (or Plain) of the Quadrant.

CHAP. I.

A Description of the Quadrant.

1. THE Limb of the Quadrant is divided into 90 equal Parts or Degrees, according to the usual manner, and sub-divided into as many equal Parts, as the bigness thereof will permit; and numbred by 10, 20, 30, &c. to 90 degrees.

2. On that Edge of the Quadrant which is next to the Left hand, where the degrees of the Limb begin to be numbred, is a Scale of Natural Tangents, the whole Scale containing 63 deg. 27 min. *fere*. Numbred by 10, 20, 30, &c. to 63 deg. 27′.

3. On the other Edge of the Quadrant, towards the Right hand, is a Scale of Natural Sines, Numbred from the Centre downwards by 10, 20, 30, &c. to 90 deg. equal to 45 deg. of the Tangents. At the end of the Scale of Sines, there is a Line of Tangents, of 45 degrees, numbred by hours, halves, and Quarters; and is called the Scale of Three Hours.

These are the Scales which are inscribed upon the two Edges or Sides of the Quadrant; upon the Superficies thereof is,

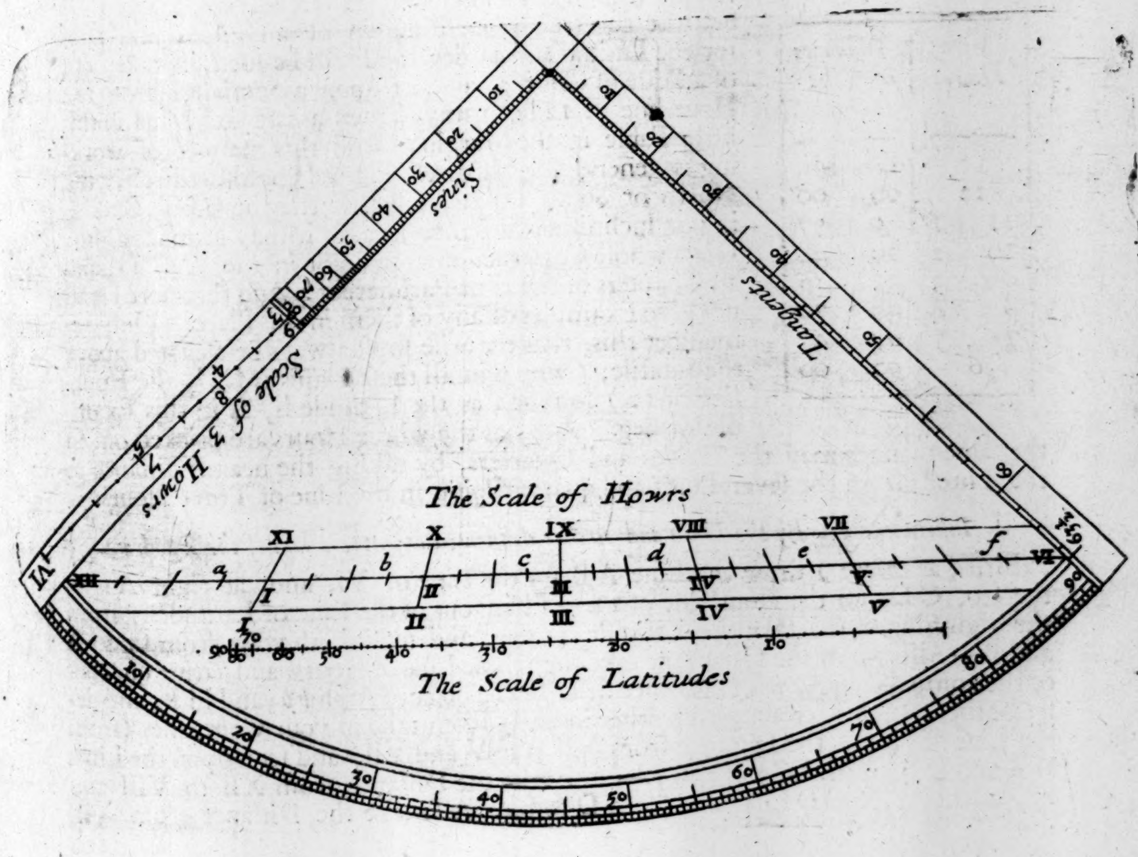
1. A Line

1. A Line of Hours divided into six unequal parts, and numbered with numerical Letters, by XII—I.XI—II.X—III.IX—IV.VIII—V.VI and VI at the other end.

2. A Line or Scale of Latitudes, divided into 90 unequal parts or degrees; by which the Latitude of the Place, or the height of the Pole (or Stile) above any Plain, is to be taken; which Line is to be divided according to the Numbers in this Table.

A Table for the dividing of the Scale of Latitudes.

1	247	17	3969	33	6764	49	8519	65	9496
2	493	18	4176	34	6900	50	8600	66	9539
3	739	19	4378	35	7036	51	8678	67	9578
4	984	20	4577	36	7186	52	8753	68	9615
5	1228	21	4772	37	7292	53	8825	69	9651
6	1470	22	4961	39	7414	54	8895	70	9685
7	1711	23	5146	38	7532	55	8962	72	9745
8	1949	24	5328	40	7647	56	9016	74	9801
9	2186	25	5505	41	7758	57	9088	75	9825
10	2419	26	5678	42	7865	58	9147	76	9846
11	2650	27	5846	43	7968	59	9203	78	9888
12	2879	28	6010	44	8068	60	9258	80	9924
13	3104	29	6169	45	8165	61	9311	85	9982
14	3325	30	6325	46	8259	12	9360	90	10000
15	3543	31	6475	47	8348	63	9408		
16	3758	32	6622	48	8436	64	9454		



CHAP. II.

To make an Horizontal Dial in any Latitude.

I. *Geometrically, By the Lines on the Sides of the Quadrant.*

Fig. I. LET our Example be of an Horizontal Dial in the Latitude of 41 degrees. First draw a right Line A B C, for the Hour-line of Six; and in that Line assure C for the Centre of your Dial. Also draw the Line C D perpendicular thereunto, for the Hour-line of 12. Then, out of the Line of Sines, take 41 deg. the Latitude, and set it from C, both ways, to A and B. Then take the length of the whole Line of Sines (*i. e.*) from 0 deg. to 90 deg.) and set it upon the Meridian (or Hour-line of 12) from C to D; and draw the Lines A D and B D.—Then, take in your Compasses the length of the Line A D or B D; and setting one foot of the Compasses in the Point VI. of the Line of Three Hours, turn the other foot of the Compasses about, till it do only touch the Thred, (which is fixed in the Centre of the Quadrant) and there keep the Thred: (which may be done by a bit of Wax, a Screw, or a Spring fitted for that purpose. Then, set one foot of the Compasses in the Point V and VII of the Line of Three Hours, and open the other till it do but only touch the Thred; and set that distance from D to 7, from D to 5, from A to 1, and from A to 11.—Also, set one foot of the Compasses in the Point IV and VIII of the Line of Three Hours; and open the other to the nearest distance to the Thred; and set that distance from D to 4, from D to 8; from A to 2, and from B to 10.—Again, set one foot of the Compasses in the Point IX and III of the Line of Three Hours, and open the other till it do only touch the Thred, and set that distance from D to 3, and from D to 9; and (if you have committed no former Error in your Operation) this distance shall divide the Lines A D and B D into two equal parts in the Points 3 and 9.—Lastly, If from the Centre C, you draw right Lines through the Points 1, 2, 3, &c. 11, 10, 9, &c. they shall be the true Hour-distances of an Horizontal Dial for the Latitude of 41 deg. and will be such, if taken out of a Scale of Chords, and set upon a Semicircle from the Hour-line of 12 both ways; such as are exhibited in this little Table in the Margin. And this manner of working is general for all direct Plains beholding directly the North or South Points, whether they be Erect, Reclining or Inclining; and therefore by it may be made all the Dials whose Construction are taught in the 5, 6, 11, and 12 Chapters of the First Part hereof: And therefore I shall not give Examples of any of them in this Place. Only remember this, that the Stile must always be elevated above the Substile, (which in all these Plains is CD, the Hour-line of 12) so much as the Latitude is, as in this Example 41 deg. And, as the whole Hours are pricked on, in the same manner may the Halves and Quarters, by taking the nearest distance to the Thred, from the several half and quarter Points in the Line of Three Hours.

Hours.		*Distances upon the Plain.*	
		De.	Mi.
12		00	00
11	1	9	57
10	2	20	41
9	3	33	16
8	4	48	39
7	5	67	47
6		90	00

II. *Instrumentally, By the Lines and Arches delineated upon the Plain of the Quadrant.*

First (as before) draw the Line A B for the Line of VI, and, at right Angles thereto, C D, for the Hour line of 12.—Then, out of the Line of Latitudes, (from the beginning of it) take the Latitude 41 deg. and set it both ways from C, to A and B.—Also out of the Quadrant take the whole Line of Hours, and setting one foot of the compasses in A, with the other describe the obscure Arch *b b*; and in B, and describe the Arch *a a*, crossing each other in D.—Then take in your Compasses (from the Line of Hours the Distance from XII) to V and VII, and set it upon the Lines D A and D B, from D, to 5 and 7.— Also take the Distance from XII to VIII and IV, and set it from D to 4, and from D to 8.— Also take the Distance from XII,

to

to III and IX, and set it from D to 3 and 9; then take the Distance from XII to II and X, and set it from D to 2 and 10.— Also take the Distance from XII to I and XI, and set it from D, to 1 and 11.— Lastly, Lines drawn from the Centre C, through these Points shall be the true Hour Lines for an Horizontal Plain, in the Latitude of 41 deg, And by this one general way of working, you may make any direct South or North reclining inclining Dial; but in South reclining Plains, observe (1,) if the Reclination of the Plain be equal to the Complement of the Latitude, the Plain is a Polar Plain, lying parallel to the *Axis* of the World, and must be made by the directions in Chap. 11. Sect. 9. Part 1 hereof, Fig. IX. (2,) if the Plain recline more than the Complement of the Latitude; then the North Pole is elevated above the Plain, so much as the Reclination is more than the Complement of the Latitude, and must be made, as in Chap. 11. Sect. 3. Part 1. hereof, Fig. XI. (3,) if the Plain recline less than the Complement of the Latitude, the South Pole is elevated so much above the Plain, as is the Difference between the Complement of the Latitude, and the Plain's Declination; and must be made as in Chap. 11. Sect. 2. Part 1. hereof, Fig. X. Also in North recliners; (1,) if the Plain recline equal to the Latitude, then the North Pole is elevated 90 deg. above the Plain; and the Dial must be made as in Chap. 12. Sect. 1. Part 1. hereof, Fig. XII. (2,) if the Plain recline less than the Latitude, the Reclination added to the Complement of the Latitude, gives the Height of the North Pole above the Plain, and must be made as in Chap. 12. Sect. 2. Part 1. hereof, Fig. XIII, (3,) if the Plain recline more than the Latitude, then the Reclination added to the Complement of the Latitude, gives the Height of the Pole above the Plain; but if the Sun exceed 90 deg. subtract it from 180 deg. and the remainder is the Height of the North Pole, and may be made by Chap. 12. Sect. 3. Part 1. hereof, Fig. XIV.

CHAP. III.

How to make an upright South or North Dial, declining East or West in any Latitude.

I. *Geometrically, By the Lines on the sides of the Quadrant.*

LET it be required to make an upright Dial, declining from the South, Eastward, 20 deg. in the Latitude of 48 deg. Fig. II.

First, Draw a right Line A B, for the Horizontal Line of the Plain, and a Line C D, Perpendicular thereunto for the Meridian, and Hour-line of 12.

Secondly, Out of the Scale of Tangents, take the Tangent of the Latitude 48 deg. and set it from C to G, and the Tangent Complement of the Latitude 42 deg. and set it from C to E, and make the parallellogram C E F G, on the left hand of the Hour-line of 12, (because the Plain declineth Eastward.)

Thirdly, Out of the Scale of Sines, take 20 deg. the Declination of the Plain, and set it from G to M; and from E to P, drawing the Line C M for the Substile, and C P for the Hour-line of 6.

Fourthly, Take 70 deg. the Complement of the Plain's Declination, and set it from C to K, and from M to N, setting M N Perpendicular to M C.

Fifthly, Take the Sine of the Complement of the Latitude 42 deg. and set it from C to H, and draw H O, parallel to E F or C G, till it cut the Hour-line of 6 in O; then make C L equal in C O, and draw the Lines O K and L K, constituting the Triangle O K L.

Sixthly, Take in your Compases, the Line K O, and setting one foot in the Point 6, of the Line of three Hours, turn the other foot about, till it do only touch the Thred which is in the Centre, and there keep the Thred.— Then setting one foot in the Point V and VII, take the nearest Distance to the Thred, and set that Distance upon your Dial Plain, from K to 7, and from O to 11.— Also take the nearest distance from the Point VIII and IV, to the thred; and set it upon the Plain, from K to 8,

and from O to 10.— Then take the Distance from the Point III and IX, to the thred, and set it from K or O to 9; for this Distance will divide the Line O K into two equal parts in 9.— Then take in your Compasses the Line K L, and setting one foot in the Point VI of the Line of three hours, bring the Thred to the nearest Distance, and there keep it; and take the nearest Distance from the Point V and VII, to the thred, which set from K to 5, and from L to 1.— Also take the nearest Distance from the Point IV and VIII to the thred, and set it from K to 4, and from L to 2. Also take the nearest Distance from the Point III and IX, to the thred, and set it from K or L to 9, for this Distance will divide the Line K L into two equal parts, also in the point 3.

Lastly, If you lay a Ruler to C, and draw Lines through the several Points 7, 8, 9, 10, 11, and 1, 2, 3, 4, 5, they shall be the Hour-lines proper for an upright Plain in the Latitude of 48 deg. declining from the South Eastward 20 deg.

II. *Instumentally, by the Lines and Arches described upon the Quadrant.*

Before this, (or any other) declining Dial can be made, three things must be first found.

1. The Deflexion, or Substile's distance from the Hour-line of 12.
2. The Height of the Stile above the Substile.
3. The Plain's Difference of Longitude.

And all these may be found by help of the Limb, and Scale of Tangents on the side of the Quadrant, and the thred, Thus:

I. *For the Deflexion, or Substile's Distance from* 12.

Set one foot of the Compasses upon the Sine of the Plain's Declination, (in this Example 20 deg.) and extend the other to the Centre of the Quadrant: The Compasses being open to this Distance; set one foot in the Tangent of 45 deg. and bring the thred to the nearest Distance, and there keep it; then set one foot in the Tangent of the Complement of the Latitude, (in this Example 42 deg.) and take the nearest Distance to the thred; this Distance measured upon the Tangent Scale from the Centre of the Quadrant, will reach to 17 deg. 7 min. and that is the Deflexion, or Substile's Distance from the Meridian.

II. *For the Height of the Stile above the Substile.*

Set one foot of the Compasses in the Sine Complement of the Latitude (in this Example 42 deg.) and extend the other to the Centre of the Quadrant; and with this Distance, set one foot in the Sine of 90 deg. bringing the thred to the nearest Distance, and there keep it; then set one foot of the Compasses in the Sine of the Complement of the Plain's Declination, (in this Example 70 deg.) and with the other take the nearest Distance to the Thred; this Distance measured upon the Scale of Sines, will reach from the Centre to 38 deg. 58 min. And that is the Height of the Stile above the Substile.

III. *For the Plain's Difference of Longitude.*

Out of the Scale of Sines, take the Sine of the Complement of the Latitude (in this Example 42 deg.) and setting one foot in the Sine of 90 deg. bring the thred to the nearest Distance, and there keep it: Then take the Sine of the Deflexion (in this Example 17 deg. 7 min.) out of the Scale of Sines from the Centre, and setting one foot of the Compasses upon the Scale of Sines, move it along, till the other foot being turned about, will only touch the thred; and so doing, you shall find the Compass Point to rest upon the Sine of 26 deg. 6 min. and that is the Plain's Difference of Longitude.

IV. *For the Hour-distances.*

Fig. IV. First, draw a right Line A B, for the Meridian or Hour-line of 12, and assuming the Point A for the Centre, upon it with 60 deg. of your Scale of Chords describe an Arch B C, upon which, set the Deflexion, or Substile's Distance from the Meridian, 17 deg. 7 min. from B to C, and draw the Line A C for the Substile: Also take 38 deg. 58 min. and set them from C to D, and draw A D for the Stile: Then, Through the Centre A draw the Line R A T, perpendicular to the Substilar A B.

Secondly, Out of the Line of Latitudes, take 38 deg. 58 min. the Height of the Stile, and set them from A both ways upon the Line R A T, from A, to R and T: Also

Alſo take the whole length of the Line of Hours in your Compaſſes, and ſetting one foot in R, with the other deſcribe the Arch *c c*, and removing the Compaſs Point to T, with the other deſcribe the obſcure Arch *d d*, croſſing the other in the Point V; then draw the two Lines R V and T V: ſo ſhall you have conſtituted the Equicrural Triangle R V T, upon the two equal ſides of which, R V and T V, the Hour Points are to be pricked down, as followeth.

Thirdly, Having recourſe to your Quadrant, and having found before that the Plain's Difference of Longitude is 26 deg. 6 min. lay the Thred to 26 deg. 6 min. counted in the Limb of the Quadrant, and it will croſs the Line of Hours in the point *b*, near three quarters after XI; take with your Compaſſes the Diſtance from XII, to the point where the Thred croſſeth the Line of Hours, and that Diſtance ſhall reach from V to 12, and from R to 6, through which points draw the Lines A 12, and A 6 for the Hour-lines of XII and VI. Then for the reſt of the Hour-diſtances, do as followeth.

The Plain's Difference of Longitude being 26 deg. 6 min from it ſubtract 15 deg. as often as you can, (which in this Example is but once) and there will remain 11 deg. 6 min. which being leſs than 15 deg. ſet down in the ſecond Column of a little Table, as here, with the word Subſtile over it, and then, continually add 15 deg. thereto, and it will be 26 deg. 06 min. (equal to the Difference of Longitude,) againſt which ſet XII; then add 15 deg. thereto, and it makes 41 deg. 06 min. and ſo adding 15 continually, till you come as near 90 deg. as you can, you ſhall find them to be as in the Table, againſt which, ſet the Hours proper for the Plain, as you ſee here done.

Hours.		*Subſtile.*	
XI	V	11	06
XII		26	06
I	VII	41	06
II	VIII	56	06
III	IX	71	06
IV	X	86	06

The Table being thus prepared.

	Deg.	Min.								
Lay the Thred to	11	06	and it will croſs the Line of Hours in	*a*	And the Diſtance from XII to	*a*	will reach upon the Plain from V, to	11	And from R, to	5
	26	06		*b*		*b*		12		6
	41	06		*c*		*c*		1		7
	56	06		*d*		*d*		2		8
	71	06		*e*		*e*		3		9
	86	06		*f*		*f*		4		10

Through which Points from A, Right Lines being drawn, as A 5, A 6, A 7, A 4, A 3, *&c.* they ſhall be the true Hour-lines proper for a South Plain, declining Eaſtward 20 deg. in the Latitude of 48 deg.

CHAP. IV.

How to make an Eaſt or Weſt Reclining Dial.

These Dials are no other than upright Declining Dials referred to a New Latitude: which New Latitude is no other than the Complement of that Latitude wherein your Plain is a reclining Plain: And the Declination in that New Latitude, is only the Complement of the Reclination.

Example. *Suppoſe that in the Latitude of* 42 *deg. an Eaſt or Weſt Plain ſhould Recline from the Zenith towards the Horizon* 70 *deg. In what Latitude will that be an upright Declining Plain?*

The Old	Latitude is 42 deg. 00 min.	Compl.	48 deg 00 min.	New Latitude.
	Reclination 70 deg. 00 min		20 deg. 00 min.	New Declin.

Wherefore ſuch an Eaſt or Weſt Plain, as in the Latitude of 42 deg. reclines 70 deg. ſhall be an Erect Plain, Declining Eaſt or Weſt 20 d. in the Latitude of 48 d.

So that the Declining Dial before made, will ſerve for an Eaſt or Weſt Dial, Reclining 70 deg. in the Latitude of 42 deg. Obſerving the Cautions given for placing of the Meridian Line or Hour-line of 12, which in all ſuch Plains muſt lie parallel to the Horizon, whereas in Erect Plains it is perpendicular thereunto.

CHAP V.

Of Declining, Reclining, or Inclining Dials; how to describe Hour-Lines upon them.

THE best way whereby to find the Requisites, and to describe the Hour-lines upon these Plains, is (as in East and West Recliners) to refer them to a New Latitude, and a New Declination, wherein they will stand as upright Declining Plains; and so may be made by the Rules beforegoing, both Geometrically by the Scales on the Sides, and by the Lines and Arches on the Superficies of the Quadrant.

I. *Geometrically, by the Scales on the sides of the Quadrant.*

Let our Example be of a South Plain, Reclining from the Zenith Northwards 60 deg. and Declining towards the East 60 deg. in the Latitude of 52 deg. 30 min.

1. *To find the New Latitude.*

Fig. III. Upon Paper or Paistboard describe a Quadrant A B C, and upon B erect the Tangent-line B D; Then from your Scale of Sines, take 30 deg. the Complement of the Plains Declination, and with that distance describe the Quadrant H E G; also take the Tangent of the Complement of the Reclination, and set it from B to D and draw the Line A D, cutting the Quadrant A H G in E: The least distance taken from E, to the Line B A, being measured upon the Tangent Scale, will be found to be 16 deg. 6 min. equal to B K.—This Tangent thus found, 16 deg. 6 min. in South Recliners, (as this is) must be compared with the Old Latitude 52 deg. 30 min. and their difference 36 deg. 24 min. is the New Latitude.

2. *For the New Declination.*

Out of the Scale of Chords take 60 deg. the Plain's Reclination, and set it from B to O, and draw the Line A O. Also take the Sine of 60 deg. the Plain's Old Declination, and set it from A to N; the least distance taken from N, to the Line C A measured upon the Scale of Sines, will be found to be 25 deg. 39 min. for the New Declination.

And thus the New Declination, and New Latitude being found, if you make a Dial for that New Declination, and in that New Latitude, it will be a South Plain declining West 60 deg. in the Latitude of 52 deg. 30 min.

New { Latitude 36 deg. 24 min.
New { Declination 25 deg. 40 min South-West.

So that if according to the Rules delivered in the foregoing Sections hereof, if you make an upright Dial to decline 25 deg. 40 min. from the South, in the Latitude of 36 deg. 24 min. It shall serve for a South Plain, Declining 60 deg. and Reclining Northward 60 deg. in the Latitude of 52 deg. 30 min.

II. *Instrumentally, by the Scales and Arches described on the Superficies of the Quadrant.*

Our Example shall be of a South Plain, Declining Eastward 30 deg. and Reclining from the Zenith Northward 55 deg. in the Latitude of 51 deg. 32 min.

Before the Hours can be drawn, four Requisites must be found.

1. The Distance of the Meridian from the Horizon.
2. The Height of the Pole or Stile above the Plain.
3. The Deflexion or Substile's Distance from the Meridian.
4. The Plain's Difference of Longitude.

All which may be found by the Scales on the Sides of the Quadrant.

1. *For the Distance of the Substile from the Meridian.*

First, Out of the Scale of Sines take 55 deg. the Reclination, and setting one foot in the Tangent of 45 deg. bring the Thred to the nearest distance, and there keep it. Then set one Foot in the Tangent of the Plain's Declination 30, and take the nearest distance to the Thred; that distance measured upon the Tangents from the Centre, will reach to 25 deg. 19 min. the Complement whereof 64 deg. 41 min. is the Distance of the Meridian from the Horizon.

2. For

Fig. I.

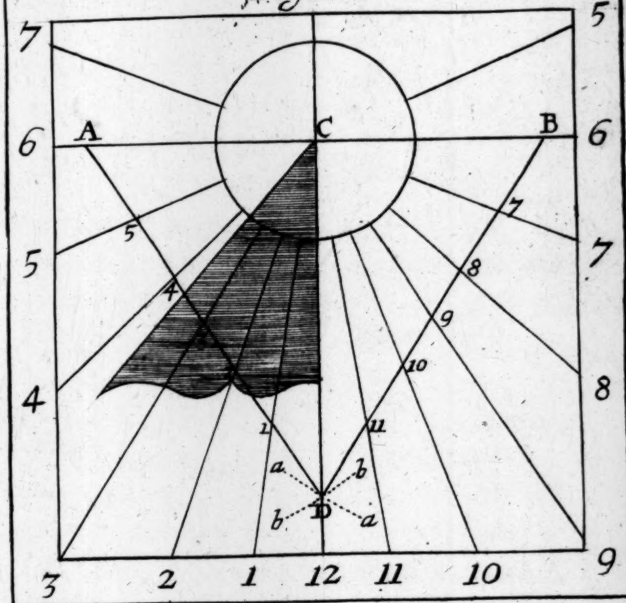


Fig. IV.

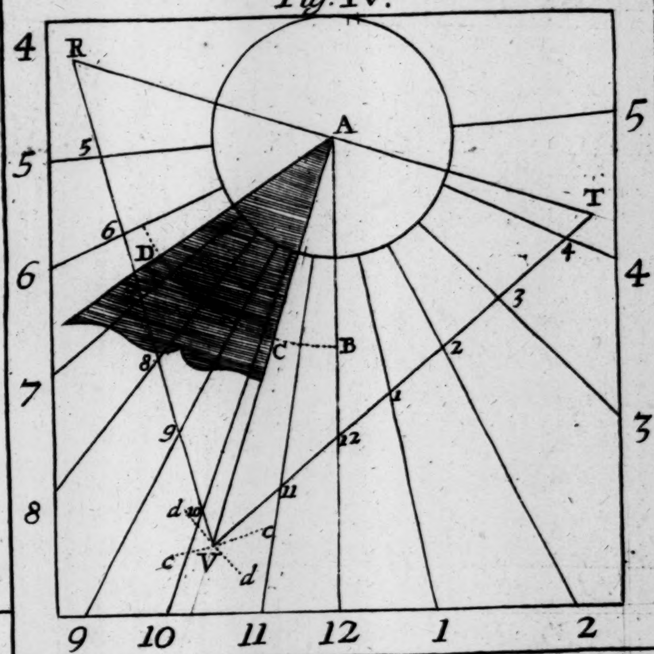


Fig. II.

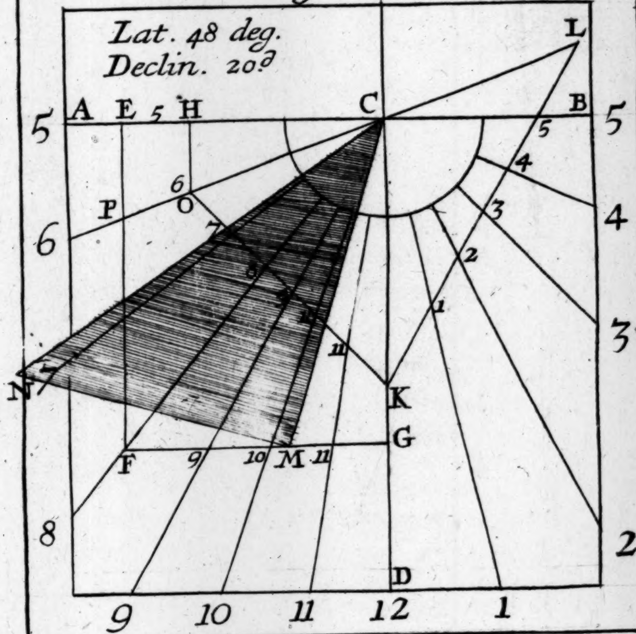


Fig. V.

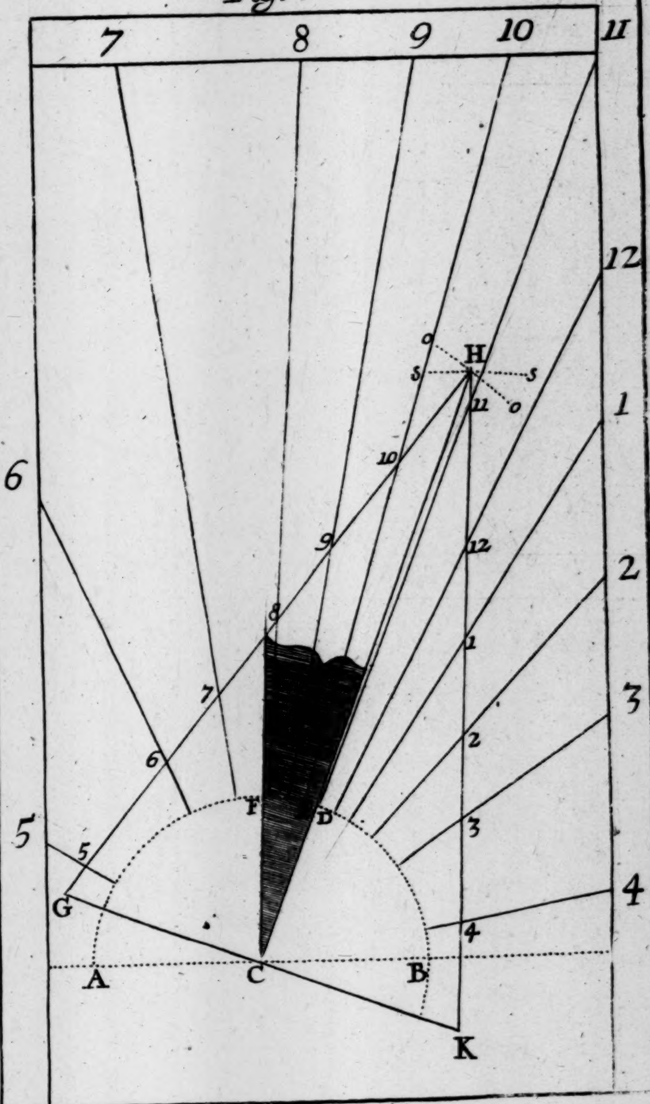
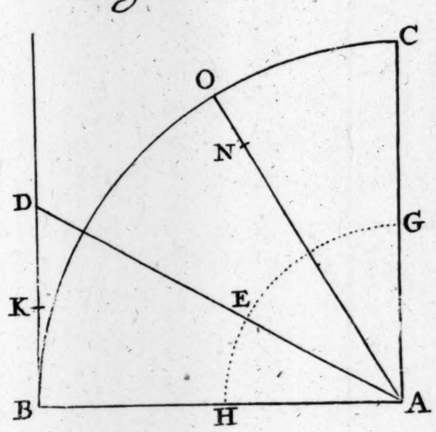


Fig. III.



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2. For the Height of the Stile above the Substile.

Take 64 deg. 41 min. the distance of the Meridian from the Horizon, out of the Line of Sines; and setting one foot in the Sine of 90 deg. bring the Thred to the nearest distance, and there keep it: Then set one foot in the Sine of 35 deg. (the Complement of the Plain's Reclination,) and take the nearest distance to the Thred; that distance will reach from the Centre to the Sine of 31 d. 14 m. which subtracted out of the Latitude 52 deg. 32 min. the remainder is 21 deg. 18 min. Then again, Take the Sine of 21 deg. 18 min. from the Scale of Sines, and setting one foot in the Sine of 64 deg. 41 min. the distance of the Merid. and Horizon, bring the Thred to the nearest distance, and there keep it. And setting one foot in 60 deg. take the nearest distance to the Thred, and that distance measured upon the Sines will reach from the Centre to 19 deg. 25 min. and that is the height of the Pole above the Plain.

3. For the Deflexion or Substile's Distance from the Meridian.

Out of the Scale of Sines, take 19 deg. 25 min. the Stile's height; and setting one foot in the Sine of 90, bring the Thred to the nearest distance, and there keep it; Then set one foot in 20 deg. 8 min. and take the nearest distance, which measured will reach from the Centre to 6 deg. 2 min. and that is the Deflexion.

4. For the Difference of Longitude.

Take out the Sine of 20 deg. 18 min. and setting one foot in the Sine of 90, bring the Thred to the nearest distance, and there keep it; then take out the Sine of 6 deg. 2 min. the Deflexion, and setting one foot upon the Scale of Sines, move it along the Line, and turn the other gently about, till it do only touch the Thred; so shall you find the Compass point to rest at 17 deg. 38 min. which is the Plain's Difference of Longitude.

5. To find the Hour Distances.

First draw a right Line A B, for the Horizontal Line of the Plain, and making choice for a Centre at C, upon C with 60 degrees of your Chords describe the Semicircle A F B. Then the Distance of the Meridian from the Horizon being 64 deg. 41 min. set them from B to D, and draw C D for the Hour-line of 12.—Then the Distance of the Substile from the Meridian being 6 deg. 2 min. set them from D to E, and draw C E for the Substile. And the Stile's height being 19 deg. 25 min. set them from E F, and draw C F for the Stile or *Axis*.---Then through C draw a Line perpendicular to the Substile C E, as G H. These things done, Fig. V.

Out of the Line of Latitudes take 19 deg. 25 min. the height of the Stile, and set that distance from C to G, and from C to H: also take the whole Line of Hours out of the Quadrant; set one foot in G, and with the other describe the occult Arch *o o*; likewise set one foot in H, and with the other describe the Arch S S, crossing one another in the Substile in the Point H. And now the Plain's Difference of Longitude being 17 deg. 38 min. subtract from it 15 deg. as often as you can, which you may in this case doe only once, and then there will remain 2 deg. 38 min. Then make a Table, by adding of 15 deg. continually to 2 deg. 38 min. the Numbers will be such as this Table exhibits.—Your Table thus finished, repair to your Quadrant; And

Hours.		*Substile.*	
V	XI	2	38
VI	XII	17	38
VI	I	32	38
VIII	II	47	38
IX	III	62	38
X	IV	77	38

	De.	*Mi.*				
Laying the Thred upon	2	38	Note where the Thred cuts the Line of Hours, for the distance from XII, taken to the Thred, will give the Distances from H to	11	and from G, to	5
	17	38		12		6
	32	38		1		7
	47	38		2		8
	62	38		3		9
	77	38		4		10

Through which Point Lines drawn from the Centre C, shall be true Hour-lines for the Declining Reclining Plain.

DIAL-

DIALLING

Projective and Reflective.

PARTS IV, and V.

CHAP. I.

Of Projective Dials.

FOR to perform the Work of this and the following Chapters, it will be necessary to have a Semicircle divided into an 180 deg. by two Quadrants beginning the Numbers at the Semidiametre, by 00, 10, 20, 30, *&c.* degrees, both ways, to 90 deg. at the Diametre, into which Diametre, a Ruler must be so fitted by a Grove, Screw, or the like; that the Semicircle may move along the Ruler, and be stayed in any part thereof: And of these Rulers, it were necessary to have 2 or 3 of them of several lengths, or (instead of a Semicircle) a Quadrant, if it be divided on both sides, and a Ruler fitted to it; it will supply the use of the Semicircle.

The use of this Semicircle (or Quadrant) in the general, is,

How, upon a Line drawn any where, to project any Altitude or Depression, above or below the Horizon, from a fixed Point that stands at a distance from that Line.

The manner how this is to be done, is very easie: For, if you hold the Edge of the Ruler to the fixed Point; and also apply the Point of that Edge of the Ruler to the Line given, removing it higher or lower, (as occasion requires) till the Thred hanging down by the side of the Semicircle at full liberty, do fall upon the degrees of Altitude (or Depression) intended; for then doth the Ruler lie at the Altitude, or Depth, and so doth Project it from the fixed Point into the Line, as was required.

It will be necessary in many Cases to slip the Semicircle higher or lower upon the Ruler, as also to change the sides of the Ruler; but in this Discretion must be your Director.

CHAP. II.

A general and easie way to project Hour-lines upon all kinds of Superficies without any regard had to their standing, either in respect of Declination or Inclination.

1. LET a Gnomon, being first sharpned into a Point, be shaped, and fastned in such wise, that it no way hinder either the draught of the Horizontal Line, or the Point of the shadow, from having free access to the Dial at all times of the Year.

2. Draw

2. Draw an Horizontal Line, by help of your Semicircle in a true Level both in regard of it self, and also to the Point of the Gnomon, through the whole Superficies on which the Dial is to be described. Or having two Points in the same Level with the Point of the Gnomon, project it upon your Superficies, if it be a rugged one. And if the Superficies be more than one, or if any of them be very much inclined toward the Horizon, or else be very rugged, or far remote from the Gnomon, so that it will not at all, or not so well, receive an Horizontal Line upon it, you may either set up some Board, or such like Object, upon which for a time you are to inscribe the Horizontal-line, and by help of which the Hours are to be projected upon the Superficies; or else (which perhaps will be better) you may extend a Thred in the Air, (it matters not which may, nor whether from the Gnomon towards the Sun, or from the Sun: whether stretcht out in one length, or with returns, so long as it lieth justly parallel, in every Point of it, to the Horizon, and in the same Level with the Point of the Gnomon:) which being fixed in this manner, will very well supply the use of the Horizontal-line: or the Horizontal-line may be partly Thred, and partly drown upon the Superficies, as occasion shall be. And upon it may any Point be transferred, and signed out by slipping knots of Thred tied upon it.

3. Upon the Superficies of the Dial, observe the Point of the Shadow of the Gnomon (making a mark at it) and the Sun's Altitude, both of them at the same instant of time.

4. By the Altitude observed, compute the Azimuth of the Sun from the Meridian.

5. The same Azimuth must be transferred unto, or projected upon, the Horizontal Line by help of a Perpendicular Thred, covering to your sight (as it hangeth down) the Points of the Gnomon and Shadow both together; and at the same view cutting through the Horizontal-line: observe then punctually where it cuts through the same Line, for that same Section being signed thereon, shall be the Azimuth projected into the Horizontal-Line.

6. Let any kind of board or past-board be now applied to the Point of the Gnomon; so, as that it may be staid, either upon the Horizontal-line, (where it may so be conveniently) or at least so placed toward the Horizontal-line, that it may have a just respect unto it, and in that posture may have some stay for the edge of it to rest upon, that after it is furnished with such necessary Lines as must be drawn upon it, it may be placed in its former just posture without any Impeachment. Upon this Plain so placed, let the Point of the Gnomon be signed, which may be called the Centre; and from this Centre, to the Sign of the Azimuth, before projected into the Horizontal Line, draw a right Line: this right Line so drawn, shall represent upon the board or past-board, the same Azimuth which was before computed.

7. Then taking away the same Plain, draw upon it the Meridian or Line of 12; extending it from the Centre before noted, as the true Angle that it hath from the Azimuth before computed and described, and also toward the true Coast of the World. And let it be extended on both sides the Centre, if need be.

8. To the Meridian so pitched upon the past-board, draw (from the Centre) the Lines of an Horizontal-dial made to that Latitude wherein you are.

9. Then again, let the plain board or past-board be applied to its former situation, the Centre of the Horizontal-dial resting upon the Point of the Gnomon, and every thing else answering to the same just posture that it had at the first. Which done, let a Thred be fixed in the Centre of the Horizontal-dial, by help whereof you may transfer every hour from the past-board into the Horizontal-line. Let every hour be therein noted (by fixing marks upon the Horizontal-line where it is drawn, or by slipping knots set upon the Thred, where a Thred Horizontal-line is used) especially mark out the hour of 12: For which (if it chance to run besides the Superficies) some kind of Object, (whereon the Horizontal-line is also to be drawn,) or an Horizontal Thred must be fastned, that may receive it, till such time as your Dial be finished.

10. After all this, take your Plain away, (for there will now be no more need of it,) and conjecture whereabout the Axis of the World would pass from the Point of the Gnomon to the Poles of the World, for into that place is the Mridian to be projected. Which that it may be done more commodiously, if no object stand in the way that will receive it, you must place one there, it matters not whether above or below the Gnomon, chuse that which is most convenient: Or, a Thred laid

aslope

aslope in the Meridian justly as it ought, will serve as well as may be. If then you hold up a Perpendicular Thred, so that by your eye you may see the Point of the Gnomon, and also the Point of 12 in the Horizontal-line, both together, the same Thred so hanging, shall shew where the Meridian is to be drawn. Or, you may extend a Thred from the Point of the Gnomon to the Point of 12 in the Horizontal-line, which Thred shall represent the Line of 12 : And staying your Thred there, close to it, hang up two Perpendicular Threds at a good distance; so shall the same two Threds give you the track of the Meridian-line.

11. The next Work will be to project one of the Poles of the World (that namely, which lies the same way that this projected Meridian doth from the Point of the Gnomon) into this Meridian. And this is done by elevating or depressing your Semicircle, from the Point of the Gnomon towards the Meridian-line, according to the Latitude of your Place; for so will the Ruler of the Semicircle, or a Thred extended along by it, sign out the very Pole Point. If now you extend a Thred from this Pole Point, to the Point of the Gnomon, the same shall represent the Axis of the World.

12. Last of all; by these helps, all the hours may easily be projected. For if the Eye do lay, or project, this Thred or Axis upon each Point of those hours that were inserted before into the Horizontal-line, the Axis upon an hour Point, or a Point upon the Axis, each one of those Projections shall represent upon your Dial each of the Hours required, and will shew upon every Object that stands in the way, where the Hours are to be drawn. Or, where convenient room is wanting to place the Eye, so as it may make this Projection, there may two Threds be used for the same purpose, one whereof must be fastned to the Point of the Gnomon, the other to the Pole designed in the Meridian-line. Then stretching one of the Threds to any of the Points noted in the Horizontal-line, and holding it there, you may take the other, and extend it to the Superficies, so as it may closely pass by the first Thred, by which Work you may make as many Points upon your Superficies as you please, through which each Hour is to be drawn. Having thus traced the way before hand, you may afterward draw the hours without any difficulty, be the Superficies never so irregular. Among which Lines, the Shadow of the Point of the Gnomon, as it creepeth along, will shew the Time of the Day.

The foregoing Problem may be propounded more generally than before, in manner following;

If a Point be assigned upon any Superficies, Flat or Curved, one or more, wherein the Hour-lines and Axis *shall concur, how to project the Hours to that Point, and to set up an* Axis *after the ordinary manner to give Shadow to them without any knowledge how the Dial standeth, in respect either of Declination or Inclination.*

1. To the Point assigned (upon any side of it) by direction of your Semicircle, or other Level, stretch out an Horizontal Thred, serving for the Horizontal-line; this Horizontal-line need not be one direct Line, but may be turned at one or more Angles, provided that it lie totally in the Superficies of the Horizon.

2. With a Perpendicular Thred held up, project the Sun into the assigned Point, and into the Horizontal Thred, and tie a little mark of Thred upon the same Horizontal, through which the Shadow cutteth. At the same instant also, take the Sun's Altitude.

3. By the Altitude taken, find out the Azimuth; This Azimuth, what ever it be, is represented by the knot.

4. Apply a paste-board to the assigned Point, and hold it flat that it may answer to the Horizontal Thred also, and upon this paste-board protract your Azimuth by a Thred extended from the Point assigned for the Centre, to the mark upon the Horizontal Thred. This done,

5. By help of that Azimuth upon your paste-board protract the Meridian-line, observing the true Coast, and quantity of the Angle from the Azimuth; and to the Meridian describe an Horizontal Dial.

6. Applying the paste-board to its place again, all things standing right as before, project all the hours into the Horizontal Thred from off the paste-board, and set marks upon the same for the Points of each several hour, which marks may be little moveable knots to slip to and fro upon the same Thred.

7. Pro-

7. Project the Meridian Point by a Perpendicular Thred upon some object into that place whereabouts you imagine the Axis of the World would pass, above or below from the Point assigned for the Centre.

8. With your Semicircle elevated or depressed (as it shall be required) from the Point assigned for the Centre, according to your Latitude project the Pole of the World.

9. Extend a Thred from the Point assigned for the Centre to the Poles of the World, which shall represent the Axis.

10. By the Point upon the Horizontal Thred, and this Axis, (either by your eye, laying the Axis to the hour-points, or laying the hour-knots to the Axis,) you may project all the hours, and draw them; Or else you may let the Axis alone, and content your self with the Pole-point projected into the Meridian, for if from the Point assigned to be the Centre or meeting of the hours and Axis, you extend a Thred to each hour-point in the Horizontal-line, and do repose (with your eye) the same Thred upon the Pole-point, then shall the Shadow of the Thred give you that hour-line, and do so in all the rest.

11. Your Thred or Axis lying in its true Situation, you may easily fit an Axis to the same Posture. If your Dial be described upon a plain Superficies, you may then (by one side of a Nominal Square, applied to a Thred or Axis, and the other side lying upon the Plain) find out the Substile, and measure from it the Elevation of the Axis above the Plain: But if the Dial be described upon a curved Superficies, you must be content to set up your Axis by the direction of the Thred only.

12. This Point assigned for the Centre being a Point of the Axis, is as it were the Apex of the Gnomon, unto which all the Work is projected. But if it be required to set up an Axis to such a Superficies, upon which the Axis and Hours will not meet in any tolerable manner, because perhaps the Axis may be but of very small Elevation above the Superficies, and yet an Axis is required: In this case, set up any point (of Wire, or such like) of such distance from the Superficies, as that the Axis and Hours may be distinct: And through that Point let it be required to make the Axis pass, you have no more to do but only to project to this Point, as before, by letting the Shadow of a Perpendicular Thred pass through that Point, and noting the same upon your Horizontal Thred, and counting that end of the Wire as your Centre, proceed as before, for the Thred that lies to project the hours is a Pattern for the Axis.

This way is as general as the former, serving to project the hours upon many Superficies, be they plain or curved, and however situate whether contiguous, or seperate, and that without any laborious Inquisition of any of their Situations, in respect of Inclination or Declination. If you will put in that Furniture which is usual, you must make some mark (notch, or button) upon your Axis, unto which (as representing the Centre of the World) by help of your Semicircle you are to project the Altitudes of such great or lesser Circles as you intend to insert; as hereafter shall be taught.

The twelve Propositions in the first way were to project to an Apex.

These twelve Propositions answerable in the second way are to project to an Axis.

CHAP. III.

From a Hole made in any Pane of a Glass Window, how to draw Hour-lines within any Room upon the Window-board, Window-Jambs, and Floor: Nay, under the Intertise where the Sun can never shine: By which, the spot of Light passing through the Hole, shall shew the time of the day, upon any of the Plains upon which the Spot of Light shall fall; or to which it may be transferred.

FIrst, if the Glass-window of any Room, one Pain or Quarry of Glass be darkned, and a hole about half a quarter of an Inch Diametre made about the middle thereof, the Sun shining upon the Window will, through that hole, cast a bright Spot of Light into the Room, which as the Sun in his motion passeth by the Window, the Spot of Light will be also removed from place to place, sometimes upon the Window-board, sometimes upon the Jambs, sometimes upon the Sides, and sometimes upon the Floor of the Room. If such a Hole should be supposed to be the *Gnodus* or Point of the top of the Perpendicular Stile of any Dial, I say from it the Hour-lines of a Sun-dial or of several Dials (for every side or part of the Room is a different Plain) may be made about the Room, If,

1. Horizontally you apply an Horizontal Dial to the Hole in the Glass-window, and extend a third Horizontally also from the Hole over every Hour-line (or half and quarter Hour-line) till it touch the Sides, Doors, Windows, Jambs, or other Objects or Impediments (standing in the way) about the Room: Then,

2. The Twelve a Clock Hour-line being both an Hour-line and an Azimuth also, you may (by a Perpendicular Thred, or Threds, transfer the same to the Cieling or Floor of your Room, or to which of them will best serve your turn, and sometime there may be occasion for both: Then,

3. In this Meridian Line find another Point, from which, a Line or Thred extended to the Hole in the Window may represent either the Direct (or Reverted) Axis of the World, and unto that Point or Points all the Hour-lines which you draw in that Room will have respect unto (or be in the same Plain with) this Axis: And therefore,

4. If you fix a Thred in one or both of these Points, (or Poles rather,) and extend that String by the Side of another String extended from the Hole over any Hour-line or Point found on the side of the Room as before, that moveable String being gently moved by the Side of the Horizontal String shall trace out (upon all Objects that it meets withal) the Hour-line which the extended Horizontal String doth represent.

CHAP. IV.

Of Reflected Dials.

REflexion is best made by a piece of Looking-glass, which is so much the better, by how much it is Thinner. for the thickness of it causeth a double Ray of Light to be Reflected; the breadth may be about half an Inch: And to prevent this double Ray of Light, colour the lower Superficies thereof with some thick Oyl Colour, or Rub it upon a rough Brick or Grind-Stone rather, which will prevent the double Ray.

CHAP V.

How from a Glass Horizontally placed (or from Water or other Liquors) to Reflect Hours upon any Superficies, Flat or Curved, one or more.

THis is for Reflected Dials within a Room, and is not yet limited to a Plain Superficies, but is general to all, Flat or Curved, lying Horizontal or standing Upright, or else Leaning. It is general, in respect of the Superficies, whereto the Description is to be made, but particular in respect of the posture of the Glass, for that is here required that it should be Horizontal. Now to place it Horizontal, do thus: Lay it into a little Board, flat and even with the Board, and either make it fast, by forcing it into the Board (the place of it being streight and just fit) or else overlay it with a Plate of Lead beaten very thin, but be sure it lie true to the flat of the Board; then with a small Level lay the Board truly Flat or Horizontal, which will be done without any great difficulty, which is to lie for the most part in a Window.

1. The Glass being laid, observe the Spot of Light that the Sun casts, and make a mark at it.

2. And immediately observe the Sun's Altitude, and find the Azimuth.

3. Then extend an Horizontal Thred in the same Level with the Glass, but within the Room.

4. Afterwards project the Azimuth into the Horizontal Thred, by holding up a Perpendicular Thred in such a place, that though it hang at liberty, you may at once discern both the mark of the spot of Light, and the Glass likewise; and then observe where the Perpendicular Thred seems to cut the Horizontal Thred; at that apparent intersection tie a short Thred for a mark of the Azimuth.

5. Apply a Past-board to the Glass, and so that it may be staid upon some rest, that after it is taken away it may be restored to the first posture without impeachment: Let it be also held Horizontally, so as that it may have full relation to the Horizontal Thred.

6. At the Glass's Centre make a Point for a Centre upon the Paste-board, and extending a Thred from the Centre of the Paste-board to the mark of the Azimuth upon the Horizontal Thred, draw upon the Paste-board that Line which the Thred so extended figures out thereon. Afterwards, unto the same Azimuth, upon the Paste-board, draw a Meridian, and to it an Horizontal Dial, and applying the Paste-board to its first Situation, project the Hours thereon, unto the Horizontal Thred, and the Knots; all which is done in the Room.

7. Then project the Meridian (by a Perpendicular Thred, covering, in appearance, both the Knot of 12 and the Glass) unto the contrary Coast to that wherein the Pole is elevated (above the Horizon) that is to say, in our Northern Climates you must project the Meridian Southwards from the Glass, because the North Pole is elevated. And in the Meridian, elevate your Semicircle from the Glass Southwards, till it rise up to your Latitude; so shall the Ruler of the Semi-Circle point out (upon some Object set to receive it) the North Pole Reflected. Or else, if that be not convenient, (because in Windows, or such like Places that stand towards the South, the North Pole will be without the Room, and so the *Axis* above the Glass, extended towards that Pole will be without also) you may in such cases find out the opposite Pole to it; that is to say, that Pole which the former reflected *Axis* being extended through the Glass, and below it, would sign out, and they may be effected in this manner:

Project the Meridian Line towards the Pole that is elevated; that is, with us towards the North Pole, and then (because the North Pole is elevated by Reflection towards the South, so, by the same reason, the South Pole must be depressed towards the North) with the Ruler of your Semi-Circle, directed even with the Centre of the Glass, express or project your Latitude downwards, (but towards the North,) so shall the Ruler of the Semi-Circle point out the reflected South Pole in the Meridian.

Now whether you will or can (most conveniently) use the reflected North Pole above the Glass, or the reflected South Pole below it, you are to take your choice, for both the one and the other of them do represent the reflected *Axis* of the World.

8. By this reflected *Axis*, and the Hour Points signed out upon the Horizontal Thred, you may easily project the reflected Hours, in the same manner that hath been heretofore declared upon any kind of Superficies, one or more, whatever they be that stand in the way.

How such Circles of the Sphere, as have relation to the Course of the Sun, may be inscribed upon all Dial Plains, whether plain, projected, or reflected.

PART V.

AS Hour-lines may be described upon all sorts of Plains, to shew the Hour of the the Day, by the shadow of a Stile or *Axis*; so may other Lines also be described upon the same Plains, which shall have relation to the Sun's Course; which shall trace out upon the Plain (by the shadow of an *Apex*, or Point in the *Axis*) the Sun's course, whereby at the same time, not only the Hour of the day may be known, but (2) the time of the year, (3) the rising and setting of the Sun, (4) the length of the Day and Night, (5) the Sun's Azimuth, or on what Point of the Mariner's Compass the Sun is at any time of the day, (6) the *Almicanthar*, or Circle of the Sun's Altitude, whereby the proportion that any object bears to its shadow is discovered, (7) the *Babylonish*, *Jewish*, and *Italian* Hours, (8) the Sine of the *Zodiack*, in which the Sun is; with (9) those Ascending, and Descending; and (10) the Circles of Position, shewing in which of the twelve Cœlestial Houses the Sun is at any time of the day, and dives other Gnomonical Conclusions; and before any of these can be inscribed upon any Plain, a convenient Point or *Apex* in the Stile must be found, for it is that which gives the shadow: Therefore,

§ I. *Of the Perpendicular Stile.*

THis must be Perpendicular to the Substile, and the top thereof determined in the Stile or *Axis*.

If the Plain be small, consider whether it be direct or declining, and much declining.

If direct, the Substile may be placed in the middest, if declining, then on the part opposite to the Declination.

The Substile well placed, (and room left for the figures,) divide it into two parts, so as that part next the Centre of the Dial, may be the Tangent Complement of the Height of the Pole above the Plane, and the other part, the Tangent Complement of the Sun's Meridional Height in the beginning of that Tropick, which is to be more remote from the Centre of the Dial.

And the *Radius* proper to these Tangents shall be the Perpendicular Stile, to be placed in the point of Division in the Substile perpendicular thereunto.

§ II. *Of the Sines, or Parallels.*

A Sine is a twelfth part of the Ecliptick, and contains therefore 30 deg.

A Parallel, according to the vulgar sense, is the Sun's diurnal Motion day by day: And because there are 47 deg. from Tropick to Tropick, there may be so many Parallels; that is, Circles which the Sun describes every 24 Hours, supposed Parallel to the *Æquator*, though not exactly so; and although there are 47 of these, yet in our Latitude of 51. 32′. we accompt but 9. *viz.* those which are the day from Sun to Sun, when it is 8, 9, 10, 11, 12, 13, 14, 15, or 16 Hours long. The Description of these parallels, and of the Signs is made the same way, only due respect must be had to the quantity of the Sun's Declination; for in all direct Horizontals, the Perpendicular Stile being *Radius*, the Tangent Complement of the Sun's Height in

any

any Sign or Parallel, at any hour of the day, set off from the foot of the said Stile, and extended to the Hour-line, gives a mark, by which the Parallel of that day shall pass: So that this work repeated so often as the number of Parallels to be inscribed, and the Hour-lines require, shall give respective points enough in each hour, to draw each Parallel by.

Example.

In the Latitude 51. 32. the Sun being in *Pisces*, (the beginning thereof,) the degrees of the Sun's Height above the Horizon at every hour being as followeth; that is, 25. 37'. at one of the clock, 21, 49'. at two; 15, 57'. at three; 8. 32'. at four, and the same for eight, nine, ten, and eleven respectively, if the Perpendicular Stile being *Radius*, the Tangents of the Complements of 25. 37'. 21: 49'. 15. 57'. 8. 32': be applied from the foot of the Stile, to the respective Hour, that is, the Co-Tangent of 25. 37'. from the foot of the Stile, to the Hours of 1 and 11, and so the others, they shall give points, in every Hourline one; by which a Line being drawn with an even hand, shall be the Parallel at the beginning of *Pisces*: And the like of all the rest.

And therefore generally in Verticals; as also in all Recliners; that is to say, upon all Planes whatsoever, draw a Horizontal Dial proper to the Plane, and inscribe the Signs or Parallels upon it, by setting off from the foot of the Perpendicular Stile, the Tangents Complements of the Sun's Height at every Hour in the beginning of every such Sign above that Plane, taken as an Horizon, the Perpendicular Stile being ever *Radius*; and at the end of these Tangents so set off, upon every respective Hour-line will be a Points; by which Point, Lines drawn with an even hand, shall give the Parallels desired. This Horizontal Dial being drawn in obscure Lines, the Dial for the Plane may be drawn afterwards: The Parallels serving, which were drawn before.

Example.

Suppose a Plane declining 30 deg. and reclining 55 deg. the Height of the Pole above the Plane 19 deg. 25 min. the Sun's Height at the beginning.

Of *Taurus* to be at the Hours of	12 H.	82 D.	5'.
	1	73	30
	2	60	3
	3	46	1
	4	31	53
	5	17	47

The Tangents of the Complements of 82, 5'. and 73, 3'. and 60, 3'. &c. set off from the foot of the Perpendicular Stile, (the said Stile being the *Radius* to those Tangents) to the obscure Horizontal Hours of 12, 1, 2, &c. give the true Distances between the foot of the Stile, and those Auxiliary Hours for the Parallel of *Taurus*, and so the other Parallels may be found.

It is true, the Height of the Sun at every Hour of the day, at the beginning of every Sign in any Latitude, is not easily found out without Trigonometrical Calculation, or by the Globes, as in Lib. 3. Part 1. Prob. 16. Page 371. where there is a Table calculated for the Sun's Altitude at every Hour of the day, when he enters into any of the 12 Signs in the Latitude of 51 deg. 30 min. And the like may be done by the *Analemma*, for any Latitude, as in the use thereof.

§ III. *Of the Vertical Circles.*

These are vulgarly called *Azimuths*; and are great Circles, whose Poles lie in the Horizon, and intersecting one another in the Zenith and Nadir of the Place.

The whole Horizon being divided into 32 equal parts, these Circles shewing those divisions are called Points of the Compass, and marked S. S b E. SSE. &c. every one distant from other by 11 $\frac{1}{4}$ degrees.

But the better way of accompting them is 10, 20, 30, 40, 50, 60, 70, &c. degrees from the Meridian.

1. In all Horizontal Dial, the Perpendicular Stile being chosen, making the foot thereof the Centre, at any convenient Distance describe a Circle, and accompt from the Meridian both ways, Arches equal to 10, 20, 30, &c. degrees, from which divisions right Lines drawn to the foot of the Stile aforesaid, shall represent those *Azimuths* upon that Dial.

2. Upon

2. Upon a prime Vertical (or South) Dial, through the foot of the Perpendicular Stile, draw a right Line parallel to the Horizon, and making the said Stile *Radius*, upon the Parallel Line set off both ways from the Meridian Tangents of 10, 20, 30, 40, *&c.* degrees, through which divisions right Lines drawn, all at right Angles, with the parallel Line, shall be the *Azimuths*.

3. Upon any declining Vertical, the same being done, shall give the *Azimuths* of 10, 20, 30, *&c.* from the Meridian of the Plane, or from the Meridian of the place, just allowance being made for the Distance of Meridians.

4. In South declining reclining Planes, the Perpendicular Stile being chosen, and made the *Radius*, the Tangent Complement of the Reclination applied from the foot of the said Stile, to the Meridian of the place, shall determine the Zenith of the place; through which, and the foot of the Stile, that is the Zenith of the Plane, a right Line drawn, shall be a Perpendicular to the Horizontal Line, which shall concurr with the *Æquator* in the Hour of 6; and therefore if from the foot of the Stile upon the said Perpendicular towards the North, (for the former application is made towards the South,) be set off the Tangent of the Reclination, a Line drawn from the end thereof at right Angles with it, shall be the Horizontal Line; upon which, the Tangents of 10, 20, 30, *&c.* (the secant of the Reclination being now made *Radius*) set from the said right Angle, Lines drawn from them to the Zenith of the place, shall be the Azimuths.

5. The Distance betwixt the Meridians being known upon the Horizontal Line, the Azimuths which were accompted from the Meridian of the Plane, may be fitted for accompt from the Meridian of the place with ease.

For example, Let that Distance be the Tangent of 20 deg. then that Azimuth which is 10 from the one, is 10 from the other also, and that which is 30 on the same side of the Substile, is 10 on the other side of the Meridian of the place, the like Method serves for any Distance.

§ IV. *Almicanters*

ARE lesser Circles of the Syhere, and may be called the Parallels of Declination from the Horizon; having in all respects the same relation and habitude to the Azimuths, that the Signs have to the Meridians, although these are accompted by 15 d. and those usually by 10 d. and therefore as in the description of the Signs, an Horizontal Dial proper to the Plane, being first (obscurely) delineated, it was shewed, that the Points thro' which the Signs or Parallels must pass upon every hour, might be had by applying the Tangents of the Complements of the Sun's Height at those Hours in those Parallels, from the foot of the Perpendicular Stile, to the respective Hours, so here making use of that Azimuth which is Perpendicular to the Plane, (which in all Planes is that which passeth through the foot of the Perpendicular Stile,) the rest of the Azimuths being also inscribed, the Tangents Complements of the Sun's Height above the Plane, when he is in any Azimuth, applied from the foot of the Stile to the said Azimuth gives a point, through which, that Height or Almicanter upon that Azimuth must pass.

And these Altitudes must be found by Trigonometrical Calculation, or by the Globes, as in Lib. 3. Part 1. Prob. 17. Page 372. where there is a Table, shewing what Altitude the Sun hath, he being upon every tenth Azimuth from the Meridian, in the beginning of every Sign in the Latitude of 51 deg. 30 min. and the like may be made by the *Analemma* for any Latitude, as in the uses thereof, or by any other Projection made for any particular Latitude.

So $z\,e$ and $s\,e$ being severally found, the Difference between them, namely $se-ze$, is the Complement of the Sun's Height above the Horizon.

Then find how high the Sun is above the Plane of the Dial at the same time, the Tangent Complement of that Height applied from the Stiles foot to the Azimuth, representing the Angle $p\,z\,s$, gives upon it the Almicanter's point, or passage.

Or because $s,\ p\,s'.\ s,\ p\,z\,s''.\ s,\ z\,s'.\ s,\ z\,p\,s''.$ the Hour from Noon, that is the Angle $z\,p\,s$ is found, which will cross the Azimuth aforesaid in the same point also.

Which Hour, if it be uneven, and unfit to remain with the rest, may be drawn obscurely.

SECT.

§ V. *Of the Jewish, Babylonish, and Italian Hours.*

THE Babylonish are accounted equal Hours from Sun rising, and may be inscribed upon any Plane by help of those two Parallels, which shew the longest, and shortest day consisting of intire hours, as here 16 and 8 hours, and of the *Æquator*; for a Line drawn through the hour of 5 in the first, 7 in the *Æquator*, and 9 in the other, is the hour of 1 from Sun rising.

Likewise in the same order, through 6, 8, and 10, shall pass the hour of 2, the like order in all.

In Winter when the Parallel of 8 hours shall fail, the other two points will serve; because the hours to be drawn are right Lines.

But after the first six hours are inscribed, the *Æquator* failing also, some other Diurnal Arch, as of 9 or 10 hours, must be described to supply that want.

The Italian hours are accounted 1, 2, 3, *&c.* from Sun-setting; to inscribe these the same Diurnal Arches will serve, and a Line drawn through them in the hours 9, 7, and 5, Afternoon, (observing the same order as before) shall be the hour of 1; the like through 7, 5, and 3, shall be the hour 23; the Night hours of 9, 10, *&c.* are the Morning hours produced.

The Jewish hours are reckoned like the Babylonish, from Sun-rising, but unequally, their sixth hour being Noon; and every hour a twelfth part of the Artificial day, of what length soever that be.

The vulgar hours proper to the Plane being first drawn, and the Diurnal Arches of 15, 12, and 9, (if it may be) divide the degrees in each by 12, and the Quotients by 15; or else (which is all one) divide the said Arches by 180, the three Quotients shall give the just times in hours or usual parts of hours from 12 of Clock upon the two Parallels and the *Æquator*; through which lines drawn by a Ruler shall be the Jewish hours desired.

Example, In Latitude 51. 32′, the Diurnal Arch of 15 hours, is in degrees 225, which divided by 180 the Quotient is $1\frac{1}{4}$. and so much the Jewish hours of 5 and 7 are distant from Noon, an hour and quarter being a twelfth part of the Diurnal Arch of 15 hours, which hour and quarter being doubled, gives the place of 4 and 8, tripled the place of 3 and 9, *&c.* from Noon, upon that Parallel of 15 hours.

In like manner the Diurnal Arch of 9 hours, is 135 d. which divided by 180, Quotient is $\frac{135}{180}$ that is $\frac{3}{4}$ of an hour, which shews the place of the Jewish 7 and 5, to be three quarters after 10 before Noon, and doubled is $1\frac{1}{2}$. which gives the place of 8 and 4, all one with our $1\frac{1}{2}$. and $10\frac{1}{2}$. and so tripling and quadrupling and quintupling of $\frac{3}{4}$ gives the places of the other hours on this Parallel of 9 degrees.

And these parts doubled and tripled as is said, will always (in this Parallel and the former) fall upon even hours, halves, or quarters of our hours, which is the only reason why these two Parallels of 15 and 9 are preferred; there being no necessity of using them more than the Tropicks or other Parrallels, only this convenieney of even parts.

Lastly, In the Diurnal Arch of 12, that is, the *Æquator*, the equal and unequal hours concur, that is, the Jewish hours of 5 and 7, with our hours of 11 and 1, so their 4 and 8, with our 2 and 10, *&c.* so that a line drawn from $1\frac{1}{4}$. in the Arch of 15 to 1, in the *Æquator*, and from thence to $\frac{3}{4}$ in the Arch of 9 is their 7, *&c.*

CONCLUSION.

I Might (in this Place) have illustrated the foregoing *Precepts* by *Figures* and *Examples*; but the *Book* swelling to a bulk beyond my Expectation, I pass that over; And the rather, because I have (in my late Book of *Dialling*, Printed *Anno* 1680.) at large insisted on these Matters, and of many other *Gnomonical* Conclusions: And so shall here satisfie the Reader, by inserting the following *Table* of *Natural Sines, Tangents* and *Secants*; which will be of great use in the putting in of the *Furniture* upon any *Dial*, whether *Plain*, *Projected*, or *Reflected*.

A Table

A Table of Natural Sines, Tangents and Secants, to every degree of the Quadrant to a Radius of 1.00000. *of great use, for the ready inserting of the Furniture into all manner of Sun Dials.*

D.	Sine.	Tangent.	Secant.	D.	Sine.	Tangent.	Secant.
0	0.00000	0.00000	1.00000	45	0.70710	1.00000	1.41421
1	0.01745	0.01745	1.00015	46	0.71933	1 03553	1.43955
2	0.03489	0.03492	1.00060	47	0.73135	1 07236	1.40627
3	0.05233	0.05240	1.00137	48	0.74314	1 11061	1.49447
4	0.06975	0.06817	1.00232	49	0.75470	1 1,036	1.52425
5	0.08715	0.08748	1.00000	50	0.76604	1.19175	1 55572
6	0.10452	0 10510	1.00015	51	0.77714	1.23489	1 58901
7	0.12186	0.12278	1.00060	52	0.78801	1.27994	1 62426
8	0.13917	0.14054	1.00137	53	0.79863	1.32704	1 66164
9	0.15643	0.15838	1.00232	54	0.80901	1 37638	1.70130
10	0.17364	0.17632	1.01542	55	0.81915	1.42814	1.74344
11	0.19080	0.19438	1.01871	56	0 82903	1.47699	1 78367
12	0.20791	0.21255	1.02234	57	0.83867	1.53986	1.83607
13	0.22495	0.23086	1.02620	58	0 84804	1 60023	1 88707
14	0.24192	0.24932	1.03061	59	0 85716	1 66427	1 94 60
15	0.25881	0.26794	1.03527	60	0.86602	1.73205	2 00000
16	0.27563	0.28674	1.04229	61	0.87461	1.80404	2.06266
17	0.29237	0.30573	1.04569	62	0.88294	1 88072	2.12308
18	0.30901	0.32491	1.05146	63	0.89100	1.96261	2.20268
19	0.32556	0.34432	1.05762	64	0.89879	2 05030	2.28017
20	0.34202	0.36397	1.06417	65	0.90630	2.14450	2.36620
21	0.35836	0.38386	1.07114	66	0.91354	2.24603	2.45859
22	0.37460	0.40402	1.07852	67	0 92050	2 35585	2.55930
23	0.39073	0 42447	1.08636	68	0.92718	2.47508	2 66946
24	0.40673	0.44522	1.09463	69	0 93358	2.60508	2.79042
25	0.42261	0.46630	1.10337	70	0 93969	2.74747	2 92380
26	0.43837	0.48773	1.11260	71	0.94551	2 90421	3.07155
27	0.45399	0.50952	1.12232	72	0.95106	3 07768	3.23606
28	0.46947	0.53170	1.13257	73	0.95630	3 27085	3.42030
29	0.48480	0.55430	1.14335	74	0.96126	3 48741	3.62795
30	0.50000	0.57735	1.15470	75	0.96592	3.73205	3.86370
31	0.51503	0.60323	1.16705	76	0.97029	4.01078	4.13356
32	0.52991	0 62486	1.17917	77	0.97437	4.33147	4.44541
33	0.54463	0.64940	1.19371	78	0.97824	4 70463	4.80973
34	0.55919	0.67450	1.20621	79	0.98162	5.14415	5.24085
35	0.57357	0.70020	1.22077	80	0.98480	5.67128	5 75877
36	0.58778	0.72654	1.23606	81	0.98768	6 31375	6.39245
37	0.60181	0.75355	1 25213	82	0 99026	7 11536	7 18529
38	0.61566	0.78128	1.26901	83	0 99254	8.14434	8.20550
39	0.62932	0.80970	1.28675	84	0.99452	9.51436	9.56677
40	0.64278	0.83909	1.30540	85	0.99619	11.43005	11.47371
41	0 65605	0.86928	1 32501	86	0 99756	14.30036	14.33558
42	0 66913	0.90040	1 84563	87	0.99862	19.08113	19.10732
43	0 68199	0.93251	1.36732	88	0 99939	28.63625	28.65370
44	0.69465	0.86568	1.39056	89	0 99984	57.28996	57.29868

The End of the Eighth Book.

CURSUS MATHEMATICUS:

BOOK IX.

OF THE

THEORY

OF THE

PLANETS:

OR,

Of the *HEAVENLY BODIES*, that have a Second Motion of their own.

In Five Parts, or Sections.

I. Of the *Phænomena.*

II. Of the *Hypothesis*, by which the *Phænomena* is Explained.

III. How all Lines and Angles may be determined from *Observations.*

IV. Of Computing the *Motions* of the *Planets* by *Tables.*

V. A New *Hypothesis*; How to *Calculate* according to it: And those *Calculations* compared with *Observations.*

By *WILLIAM LEYBOURN*, Philomathemat.

LONDON,

Printed *Anno Domini* MDCXC.

OF THE THEORY OF THE PLANETS:

OR,

Of the *Heavenly Bodies*, that have a Second Motion of their own.

Proœm.

THIS Ninth Book of the Theory *of the* Planets, *is a Translation of Mr.* Nicholas Mercator *of* Halsatia, *his Second Book of* Theorical Astronomy, *by him published in Latin,* Anno 1676. *And the Method which he observes in it is This :* (1.) *I will lay down the* Phænomena, (i. e.) *those Things that appear in, or relating to the* Heavenly Bodies ; *upon the Observation of which men first began to think of other Motions beside the first.* (2.) *I will deliver the chief* Hypothesis, *by the help of which they have endeavoured to demonstrate, or give an Account of what they have observ'd.* (3.) *I will shew the manner, how all the parts of the* Hypothesis *might be determin'd by the Observations that have been made.* (4.) *I shall bring the Tables, that have been made according to the determin'd Lines and Angles ; and also explain the Use of them by* Rules *and* Examples *too, as far as may be.*

SECTION I.

Of the Phænomena.

OF the *Phænomena*, which arise from other Causes than the daily Motion that has been explained in the former Part ; some are common to all the Stars, others are peculiar to these or those particularly.

1. In the first place 'tis observ'd, as to all the Planets, That they do not always rise or set in the same places of the *Horizon* ; but that they rise sometimes from that place where the Sun rises in *Summer*, and sometimes from that where it rises in *Winter* ; and in like manner, that they go down sometimes in the place of the *Winter-Sun-setting*, and sometimes in the place of the *Summer-Solstice*. Again, That under the *Meridian* they go sometimes higher towards the *North*, and sometimes lower towards the *South*. Besides, That there are certain Bounds or Limits, beyond which they neither run *North* or *Southward* in their rise or setting ; nor are they elevated or depress'd beyond them, when they are culminant.

2. 'Tis found, That sometimes all the *Planets* move faster, sometimes slower.

3. That sometimes they appear greater, and sometimes less, though at both times the Refractions be the same, as being in the same Altitude, or in the same Temperature of Air.

4. That they have divers Situations, both with relation to one another, and also to the fixed Stars: And that sometimes in their Conjunctions or Approaches to one another, the fixed Stars are cover'd by the Planets, and sometimes the Planets by one another; and yet not all alike with respect to all the Inhabitants of the Earth.

5. But particularly as to the Sun, 'tis observ'd, That after it is set, it has certain Stars visibly apparent, that will set after it, which some days after appear no more; and that when 'tis about to rise, it has some before it that appear not, which yet after some days appear, and rise before it.

6. That the Sun spends 187 Days in passing from the *Vernal* to the *Autumnal Æquinox*, and but 178 in passing on from the *Autumnal* again; so that it tarries nine whole days longer in the *Northern* than in the *Southern Signs*.

7. That the Sun sometimes suffers a total Eclipse, but for the most part only a partial one; and both these only in the New of the Moon, and yet not in every New Moon neither.

8. That the greatest Declination or Departure of the Sun from the *Æquator*, as well *Northward* as *Southward*, seems to be grown less; since it is not now accounted so great as it has been formerly.

9. As to the Moon, 'tis observ'd, That from the New, or Change of it, it does day by day so remove from the Sun, that it does always go more and more towards the more *Eastern* Stars, till it hath perform'd its Circuit.

10. That in every Lunation (or Time betwixt Change and Change) it has divers *Phases*, or appearances: In its Increase it appears horned, or something resembling the form of a Sickle; by and by it appears halfed, or, as it were, cut in two; and afterwards gibbous, or bunching out on both sides: and then after the Full, when it decreases, it again becomes gibbous, halfed, and horned.

11. That it does likewise sometimes suffer a total Eclipse, but oftner a partial one; and both only when 'tis in the Full, and yet not in every Full neither; but for the most part once in six Months, and sometimes in five.

12. Lastly, That it departs from the *Æquator* as well *Northward* as *Southward*, sometimes more, and sometimes less than the Sun does.

13. As to *Mercury* and *Venus*, 'tis observed, That they constantly accompany the Sun; and as for *Venus*, she scarce ever goes farther from him, than about half a Sign, and *Mercury* not a whole one.

14. And at the same time, That they sometimes go before the Sun, or are seen early before its rising; and sometimes follow the Sun, rising in the evening after the Sun sets.

15. That they sometimes are direct, that is, move into the Signs following, or according to the Order and Succession of the Signs, as from ♈ into ♉, from ♉ into ♊; but sometimes contrary to the Order of the Signs, as from ♈ into ♓, from ♓ into ♒; and sometimes that they are Stationary, that is, for some times they seem to move neither into the antecedent nor consequent Signs.

16. That their Digressions also, or Departures *North* and *South*, are sometimes greater, sometimes less than that of the Sun.

17. As to *Mars*, *Jupiter*, and *Saturn*, 'tis noted, That they are not so tied to the Sun as are the other two, but do so depart from it, that sometimes they are in opposition to it, or remov'd from it six whole Signs.

18. That every year they proceed more and more towards the *Eastern* Stars; but yet that sometimes they are Direct, sometimes Retrograde, and sometimes Stationary.

19. That they are always Retrograde, and are both swiftest in their Retrocession, and greatest in Aspect or Appearance, when being in opposition to the Sun they shine all night above the *Horizon*: And that a larger space of Retrogradation belongs to *Mars* than to *Jupiter*, and to *Jupiter* than to *Saturn*; but then again, that a longer time of Retrogradation belongs to *Saturn* than to *Jupiter*, and to *Jupiter* than to *Mars*.

20. And

20. And lastly, That they also depart sometimes more, and sometimes less from the *Æquator* than does the Sun.

21. In the last place of all, as to the fix'd Stars 'tis observ'd, That they do not always keep the same distance from the Æquinoctial Points; and that they do likewise move, but that very slowly, towards the consequent Signs; and (as it appears to some) unequally, that is, sometimes more swiftly, and sometimes more slowly: For, as for instance, the Star call'd *Spica Virginis*, which (not long after the Death of *Alexander*) *Timochoris* observ'd to go before the Point of the Autumnal *Æquinox* eight degrees, was observ'd, 200 years after, by *Hiparchus*, to go before it only six; and 260 years after that, *Ptolomy* observ'd not much more than three: That I may not add, that at this time, or 1500 years after that last Observation, 'tis observ'd, that the forementiond Star follows the same Point almost eighteen Degrees: In like manner the first Star in Aries, which, in the time of *Timochoris*, was distant from the Vernal *Æquinox* only two Degrees, is now found to be distant more than twenty eight: So also 'tis worthy to be mention'd, that the Star at the end of the Tail of the Lesser Bear, which is call'd the Pole-star, is now only two Degrees distant from the Pole, with a little above half a Degree more; whereas, in the Time of *Hipparchus*, it was distant more than twelve: And so of the rest.

SECTION II.

Of the Hypotheses, *by which the* Phænomena *now premis'd may be explain'd.*

THE *Hypotheses* that have been invented to explain and solve these *Phænomena* are many; but they may all be reduc'd to these principal ones, namely, that which supposes the Earth to be Immovable, and that which supposes it to move. Whether of these is the more ancient does scarce appear, for the *Pythagoreans* did long ago reckon the Earth among the Plannets; yet because before *Copernicus*, there was scarce extant any exact Demonstration of the *Phænomena* by the Motion of the Earth, and so since *Ptolomy's Hypothesis* is not a little older, therefore I shall first of all briefly lay down this and explain it, and then afterwards discourse of the other.

CHAP. I.

Of the Motion of the Sun.

1. HOW the various rise and setting of Stars, sometimes in one, and sometimes in another part of the *Horizon*; as also how their Ascent under the *Meridian*, and lastly, how the Approaching of the Planets to the fixed Stars, and their departing from the same, may be demonstrated, is evident from the Spherical part of *Astronomy*, which gave us the Oblique Circle, call'd the *Zodiack*, for the salving of these Motions.

2. The Sun's sometimes appearing greater than it self, and this in the same Altitude above the *Horizon*, (unless the Refraction may seem to be the cause,) is a plain Argument, That at some seasons 'tis farther from the Earth, and at others nearer again. If we consider its Approachment to the fixed Stars, and its Departure from them, we are convinc'd that its Motion is Circular, or Elliptical, and so running back into it self again. If therefore the Sun run round, and be sometimes nearer, and sometimes farther off, that Circle which it runs must needs be Eccentrical: For though in an Elliptical Circle, that is concentrical, the movable Body may be at some times farther from the Centre than at others; yet 'tis otherwise in the Sun, which approahces nearer the Earth but

once

once a year, and once a year departs farther from it; whereas in concentrical Elliptick, the movable Body is twice in its Apogée, and twice in its Perigée; therefore the Sun moves in an Eccentrick.

3. The Motion of the Sun in the Eccentrick from the Earth, seems to be unequal; that is, in Figure I. the Angle A T ☉ in equal spaces of time is not equally increas'd; for the Sun being about the Apogée A, does increase every day less than 59′, but being about the Perigée P, every day more than 59′. This is plain from ☉'s continuing longer in the *Northern*, than in the *Southern Signs*: For supposing ♈ ♋ ♎ ♑ to be the Eclipitick, whose Centre let T be; now though the Semicircle ♈ ♋ ♎ be equal to the Semicircle ♎ ♑ ♈, yet does the Sun scarce finish the former in 187 days, but the latter it runs through in 178.

Fig. I.

4. Yet does not this hinder, but the Motion of the Sun from a certain other Point out of the Earth T, as for instance from C, the Centre of the Circle A ☉ P, may appear equal; that is, the Angle A C ☉ may be seen to be equally increased in equal spaces of time, *viz.* every day 59′, 8″. for so it will come, that while the motion about C appears equal, the same about T may seem unequal: And this also follows from thence, that seeing C is the Centre of the Circle A ☉ P, about which the Motion is conceiv'd to be equal; therefore the same Motion in its very Circle becomes equable and uniform.

5. Now in the Scheme I have given, the Distance of the Points T C, that is, of the Earth, from the Centre of the Eccentrick, is call'd commonly the Eccentricity: And the same T C, being continued on both sides to the Circumference of the Eccentrick unto A and P, it makes the Line of the *Apses* A P. For A, the farthest Point from the Earth, is call'd the Apogée, and *Aux*, and the *Highest Apse*; as the Point P, that is next to the Earth, is call'd the Perigée, and also the opposite to the *Aux*, and the *Lowest Apse*. And farther, if to the Line C ☉, drawn from the Centre of the Eccentrick C to the Sun in its Circle, be drawn another Line parallel to it, *viz.* T M, or T Q, this Line is call'd the Line of the Middle Motion of the Sun, and is to be continued even to the Ecliptick unto *m*, where it denotes the Sun's middle place; as the Line of its true Motion, T ☉, being continued from the Earth through the Centre of the Sun, even unto *v*, does denote there the true place of the Sun in the Ecliptick: So that the difference between the middle and true place of the Sun, is that Arch of the Ecliptick *v m*, or the Angle *v* T *m*, and that which is equal to it, *viz.* T ☉ C, which they call the Equation, and also the *Prosthaphærisis*, a word compounded of the name of Addition and Subtraction: For in the former Semicircle A M P, which they also call the Descendent (because the Sun does in it descend from the Apogée into the Perigée,) the Arch *m v*, or the *Prosthaphærisis*, is substracted from the Middle Motion of the Sun ♈ ♋ *m*; so that ♈ ♋ *v* remains the true Motion of it. But in the latter Semicircle P Q A, (which is also call'd the Ascendent,) the Arch of the Ecliptick *m v*, or the *Prosthaphærisis*, is added to the Middle Motion of the Sun ♈ *m*; so that ♈ *m v* becomes the true. Now to find out the *Prosthaphærisis m* T *v*, or T ☉ C, is requir'd the Angle A C ☉, (to which is equal A T M,) call'd the middle Anomaly of the Sun or the Argument, as A T ☉ is call'd the true Anomaly, or the Co-equate. Lastly, If upon the Line of the *Apses* A P, be from T erected a perpendicular R T S; this is call'd the Line of the Middle Longitudes, because the Sun moving in the Eccentrick A R P S, as in A it is the farthest from the Earth, and in P the nearest; so in the middle Longitudes R and S, it is at its middle, or in different distance from the Earth.

6. Nor is it to be conceal'd, that the Line of the *Apses* A P, has indeed the point T fixed; but yet the Line itself, together with its whole Eccentrick, is carried by little and little towards the following signs; so that as time goes on, the Angle ♈ T A increases more and more: At present the Point A is under the sixth Degree of ♋, in the following Age it will be under the seventh, and so on.

7. And this also you may take notice of, if you please, That the Eccentricity C T to some has seem'd to be changeable; for that which is now near upon the 28th part of the Eccentrick Ray C A, was formerly greater, or else less: Others say, that Opinion arose from the Uncertainty of ancient Observations, and that nothing is to be determin'd concerning the Change of the Eccentricity,

city, before it be confirm'd by more certain Tokens, which cannot be done without the more diligent Observations of more Ages still.

8. But though the change of the Obliquity of the Ecliptick may seem to be owing to the like uncertainty of Observations; yet if you desire an Account of it, it may be salved by conceiving a certain sort of wavering Motion of the Poles of the Ecliptick, by which they do very gently nod, as it were, to and fro, under the Colour of the Solstices, towards the Poles of the *Æquator*; whence it comes to pass, that the Ecliptick it self must needs be sometimes parted more from the *Æquator*, and again sometimes less.

CHAP. II.

Of the Equipollency of the Homocentre-Epicycle, and of Eccentrick, in Salving the Motion of the Sun, and of other Planets.

1. I Call that Circle an Homocentre, which has the same Centre that the Earth has; and an Epicycle is a little Circle that has its Centre fix'd in the Circumference of a greater, together with which Circumference it is carried round: Therefore an Homocentre-Epicycle, is a greater Circle, that has the same Centre with the Earth, and that in its Circumference carries about with it the Centre of the Epicycle, and so the Epicycle it self. Thus in Scheme II. if A be the Centre of the Earth, and also the Centre of the Circle A C E F, this will be the Homocentrick Circle, and its Circumference is fixt C, the Centre of the Epicycle C D G. Therefore the greater Homocentrick Circle A C E F, together with the Epicycle C D G, is, by a compounded name, call'd the Homocentre-Epicycle; just as in like manner the Circle B D E F, having its Centre B different from the Centre of the Earth A, is an Eccentrick, in this place, without an Epicycle: but if to this Eccentrick Circle you should add an Epicycle, whose Centre should be carried about in the Circumference of the Eccentrick, it would be call'd, by a compounded word, an Eccentre-Epicycle. Fig. II.

2. Now if the Ray A C of the Concentrick A C E F be suppos'd to be equal to the Ray B D of the Eccentrick B D E F, and the Ray C D of the Epicycle be suppos'd equal to the Eccentricity A B; besides let two Motions be imagin'd, the first of the Centre of the Epicycle C, in the Circumference C E F, and of the Planet it self, the Sun for example, in the Circumference of the Epicycle from G to D, and so on, till it return to G again; so that the Motion of the Planet in the Epicycle, in the Semicircle farthest from the Earth A, be contrary to the Motion of the Centre of the Epicycle carried from C through E and F; but in the nearer Semicircle let them tend the same way, and let the Revolutions, as well of the Planet in the Epicycle, as of the Centre of the Epicycle in the Circumference of the Homocentre, be not only equable and uniform, that is, going on equally in an equal space of time, but let both the Revolutions also be perform'd in the same Compass of time, so that the right Line C D, drawn from the Centre of the Epicycle C, to the Body of the Planet D, may always remain parallel to itself, as may be learnt from the Scheme. And then let the Sun be conceiv'd to move separately in the Eccentrick B D E F, with an uniform Motion, that is to be finish'd in the same time that the Homocentre A C E F is rolled about. These things being suppos'd, I say, there is a perfect Equipollency, or 'tis the same thing, whether according to the first way the Sun be mov'd in the Circumference of the Epicycle that is carried about in the Homocentre, or whether after the other manner it go about in the Eccentrick alone; for in both Cases 'tis plain, it will have the same place. And in this *Hypothesis* of Homocentre-Epicycle the Line of the Middle Motion A C, is drawn from the Centre of the Earth to the Centre of the Epicycle; but the Line of the true Motion is A D, drawn from the Earth to the Body of the Planet in the Epicycle.

The

The Demonstration.

In the Quadrilateral or fourſided Figure A B C D, take A for the Earth, B is the Centre of the Eccentrick, C the Centre of the Epicycle, D the Sun. In the *Hypotheſis* of the Homocentre-Epicycle, the Line of the Middle Motion A G, together with the Line of the Apogée G A B C, makes the Angle C A G, (the ſpace of which the Line of the Middle Motion is departed from the Apogée,) to which, according to ſuppoſition, the Angle G C D is equal, or the Arch G D, (the ſpace of which the Sun is departed from the Apogée of the Epicycle;) ſo that it is in the Point D. If therefore from the Centre of the Eccentrick B, you draw a ſtreight Line B D, to the Sun D, it will be equal and parallel to A C, ſeeing they are joyned by Lines that are parallels and equals, and ſo the Point D will fall into the Circumference of the Eccentrick; and alſo the Angle C B D, being equal to the Angle C A G, proves, that the Sun in the Eccentrick came in the ſame time to the ſame Point D, that it had come to it in the Epicycle, which is the thing, that was to be Demonſtrated.

CHAP. III.

Of the Æquations of Time.

SInce all Motion is in time, therefore the very Motions of the Stars are circumſcrib'd in certain Periods of time; but yet again 'tis the daily and yearly Motion of the Sun, that deſcribes and divides Time: So that the one cannot be underſtood without the other; that is, neither Time without Motion, nor Motion without Time. But farthermore in all Heavenly Motions, there is a certain Inequality or Irregularity, as 'tis plain, concerning the Sun, from what has been ſaid. Now Time, which as a meaſure is applied to ſuch various Motions, and which are every moment alterable, ought to be as uniform and equable, as poſſible, that a confuſion that cannot be rectified may not ariſe. But now ſince ſuch a moveable Body, that by its Motion does meaſure out an uniform and equable Time, can no where be found; therefore Aſtronomers are of different opinions, whilſt every one frames to himſelf, what to him ſeems moſt agreeable. But howſoever they differ, we muſt ſuppoſe ſome ſuch moveable Body, as is continually rolled about to the Meridian in the very ſame ſpaces of time, and ſo makes an equable day; and alſo that it moves uniformly to the Equinoctial Points, and ſo meaſures out a Tropical Year of an indifferent Quantity. Now to me there ſeems nothing more fit for this, than a certain fictitious or ſuppoſed Sun, that in a moſt regular Motion, and that equal to the middle Motion of the Sun, may move, not in the Ecliptick, but in the *Æquator* itſelf; whence it would come to paſs, that while the ſuppoſed Sun is moved from the Meridian to the Meridian again, all the Degrees of the *Æquator*, in number 360, would paſs one after another; and beſides, that part of the *Æquator*, which the ſuppoſed Sun had in the mean while paſs'd through by its middle Motion, *viz.* 59′. 8″. and ſo one day would perpetually be equal to another, which therefore I call the Aſtronomical day; becauſe 'tis very fit for computing the Motions of the Stars by, and Aſtronomers in their Tables can uſe none other than this. Different from this is the apparent or Natural day, which the true Sun does make by his apparent Motion, being moved from the Meridian to the Meridian again.

Which apparent Motion of the Sun, 'tis certain, is unequal, as is evident from what goes before; for the Sun does continually move faſter and faſter or elſe abate of its Motion: Whence it comes, that that portion which is daily to be added to the perfect Revolution of the *Æquator*, is not always of the ſame quantity; and if it ſhould be ſo, yet there are not equal portions of the *Æquator* (between the Circles of Declinations, that go through the Sun's yeſterday's and to day's Place) to anſwer thoſe portions, which by the Sun are daily gone through in the Ecliptick.

tick. Hence the apparent days must needs be unequal. Now the difference of Time, which is between the true and supposed Sun's coming to the same Meridian is that Equation of Time, which is here treated of: For sometimes the supposed Sun comes sooner to the Meridian than the true one, and then the Noonday of the Astronomical Time comes before the apparent Noon-day; that is, the Astronomical Time is reckon'd twelve hours, when the apparent Time is not reckon'd many; though in reality it be altogether at the same moment of Time, which is call'd by divers Names, according to the first it being reckon'd more of the Clock than according to the last. But again, on the other hand it sometimes happens, that the true Sun comes sooner to the Meridian than the supposed one; and then, according to the apparent, 'tis reckon'd twelve a Clock, when according to the Astronomical Time 'tis not reckon'd so much. Now 'tis plain, that the difference that is between the coming of the true Sun and of the supposed Sun to the Meridian, is the Arch of the *Æquator*, that is between the place of the supposed Sun and the right Ascension of the True, which Arch, if it be turned into Time, by reckoning 4′ of an hour for every Degree, we shall then have the Equation of Time. In Scheme III. let ♈ be the true *Æquinox*, ♈ M V part of the Vernal Quadrant of the Ecliptick, ♈ *r m v* the *Æquator*, M the middle place of the Sun in the Ecliptick, V the true place: Let the Arch ♈ *m* be suppos'd equal to the Arch ♈ M, and the Arch ♈ *v* to the Arch ♈ V; and so let *m* be the place of the Sun suppos'd in the *Æquator*, as far distant from ♈ as M is distant from it: Let V *r* be the Circle of Declination, passing through V the true place of the Sun, and in the *Æquator* making its right Ascension in the Point *r*. Now therefore the Equation of time is the Arch *r m*, that lies between the supposed Sun *m*, and the right Ascension of the true Sun *r*. And in this example the true Sun V with its right Ascension *r*, comes sooner to the Meridian, than the supposed Sun M: wherefore the apparent Noon-day comes sooner than the Astronomical. You may also observe, that the Arch *r m*, which makes the Equation of time, is alway either the Summ or the difference of two Arches, of which one is the difference of the true Motion of the Sun, and of its right Ascension, and the other the difference of the true and middle place of the Sun. Thus in this Example the difference of the true Motion of the Sun ♈ V or ♈ *v*, and of its right Ascension ♈ *r* is *r v*; and the difference of the true and middle place of the Sun M V, or *m v*. Now therefore if from *r v* you take away *m v*, there remains the Arch of Equation *r m*, to be turn'd into time. The like Examples in the other Quadrants of the Ecliptick, every Student in Astronomy may draw to exercise himself by. Fig. III.

CHAP. IV.

Of the Motion of the Moon.

1. Because the Moon, as well as the Sun, and the rest of the Planets, moves sometimes faster, and sometimes slower; hence it comes, that its Longitude in the Zodiack is variously alter'd. But besides, because both the Moon, and the lesser Planets do go wide of the *Æquator*, sometimes more, and sometimes less than the Sun: This occasion'd the Consideration of their Latitude or Departure from the Ecliptick: Wherefore in the Sun indeed its Longitude was only to be consider'd, but in the Moon, and the other Planets, we are to consider both Longitude and Latitude.

2. Now as in the Sun we find but only one Inequality of Motion, that is to be made up in a perfect Revolution; so we find, that the Moon, and the other Planets, are liable to a twofold Inequality of Motion; both of which do indeed come into a kind of roundness of Motion (or are made equable) in a certain space of Time: But since there is not a Revolution of both in the same time, therefore from the various compounding or Conjunction of this twofold Inequality, there arises a various Complication of Motions, which

that we may distinctly understand, it will be best to take a View of both Inequalities separately from one another.

For the one, which is called the first, is absolute of it self, because it happens to the Moon and Planets, without any Relation to their Configurations with the Sun: But the other, in the Moon, is called the Monthly; and in the Rest, the Yearly; and also the second Inequality, as being tied to, and depending upon the Moons monthly Congress, or coming together with the Sun; or of the Sun with the Superior Planets: Or, lastly, Upon the Revolution of the Inferior on this side, or beyond the Sun.

3. The first Inequality of the Moon *Ptolomy* explains by an Epicycle, the latter by an Eccentrick: But since the Eccentrick does not only carry an Epicycle, but does also influence its Motion, and in some sort govern it; therefore the second, or the monthly Inequality of the Moon, is first of all to be understood.

Fig. IV. Now therefore in Scheme IV. Suppose T to be the Earth, A T E the Line of the middle Motion of the Sun, going on together with the middle place of the Sun every day 59′, 8″, and governing this second Inequality of the Moon; which monthly Inequality, if it should be made up only once in every Lunation, (*i. e.*) betwixt every Change and Change, the Motion of the Moon's Eccentrick would differ in nothing from the Sun's; and, as in the *Syzygies*, (by which common Name the Full, as well as the New of the Moon, is meant,) the Centre of the Eccentrick is in the Line of the middle Motion of the Sun T A, namely, in the Point I, so it would perpetually continue in the same Line of the middle Motion of the Sun; and the Moon in every time of its going from, or returning to the Sun, would come once to the Perigée of the Eccentrick, and once to the Apogée. But now, since in every Lunation the Motion of the Moon is twice quickned and abated, by reason of this second Inequality; therefore it must needs be twice in the Apogée, and twice in the Perigée of the Eccentrick: In the Apogée at every Change and Full, in the Perigée in every Quadrature.

This then may be done, if we conceive these three Lines, First, Of the middle Motion of the Sun. Secondly, Of the Moon's monthly Apogée. Thirdly, Of the middle Motion of the Moon, which in the midst of every New and Full Moon do fall into one Line A T E; but after every New, or Full Moon, they are so parted, that the Line of the middle Motion of the Sun lies in the midst between the other two, which lie on each side at an equal Distance: For let the Line of the monthly Apogée A F, which has the point A farthest from the Earth, and the point F nearest, be conceiv'd to be fixt indeed at the Point T, but in the whole length besides to be moveable; so that from its first Situation A 1 F, it may be carried to a second B 2 G, and thence to a third, C 3 c, from thence to a fourth D 4 H, and last of all to a fifth E 5 I. And so while the Apogée of the Eccentrick passes through the Points A B C D E, on the other side the Perigée passes the Points F G c H I. And the Point 1, (which is the Centre of the Eccentrick,) that lies between the Apogée A, and the Perigée F, does in the same time pass the Points 1, 2, 3, 4, 5, and so does by its motion make the little Circle 1, 2, 3, 4, 5: But now if from the Centres 1, 2, 3, 4, 5, be made Circles, whose Semidiametre shall be the space between 1 A, or 1 F; they will give the Position or Situation of the Eccentrick at the several times between the New and the Full of the Moon: For as for the other half, which is from the Full to the New of the Moon, it was not convenient to express it in the Scheme, lest there should be too much Confusion. Now suppose this Motion about the Point T, to be equable, proceeding day by day towards the Antecedent Signs, (that is from A towards B,) eleven degrees and two minutes; so that its return to the Line of the middle Motion of the Sun A T E, may be in a Synodical Month, that is in that space of Time in which the Moon departs from the Sun, and returns to it again, *viz.* in twenty nine days, twelve hours, and forty four minutes. But the Line of the monthly Apogée is something longer in running through the whole Zodiack, *viz.* thirty two days, three hours, and almost five minutes. For since the Line of the middle Motion of the Sun, while the monthly Apogée goes back into the Antecedent Signs, does for its part go forward into the consequent Signs, and

and ſo moves towards the other; thence it comes to paſs, that they meet one another ſooner than the Line of the Apogée can have gone through the whole Zodiack. And the Line of the middle Motion of the Moon departing likewie from the ſame A T E, it is alſo equally moved about T into the conſequent Signs from the poſition T A, to the poſition T *b*, thence to T *c*, T *d*, T E; ſo that the Angles, which the Lines of the monthly Apogée, and of the middle Motion of the Moon, do make on both ſides to A T E, the Line of the middle Motion of the Sun, are conſtantly equal, A T B to A T *b*, and A T C to A T *c*, *&c.* Now this Line of the middle Motion of the Moon does every day proceed thirteen degrees and eleven minutes; ſo that its Revolution to the ſame place of the Zodiack is performed in twenty ſeven days, ſeven hours, and forty three minutes; which makes a periodical Month: For the Sun being in the mean while gone a whole Sign from the former place of Conjunction, the Moon does not overtake it till two days after. Hence it comes, that the Moon changing, and the Line of the middle Motion of the Sun being almoſt in the midſt, when the Apogée of the Eccentrick is in B, the Centre of the Epicycle (though the Epicycle be not yet expreſs'd in this Scheme) is in *b*: When the Apogee is in C, the Centre of the Epicycle is in *c*; when in D, the Centre of the Epicycle in *d*; till ſuch times as they meet one another in E. And farther, hence it comes to paſs, That when at the New Moon the Centre of the Epicycle is in the Apogée of the Eccentrick in A; then, when it has paſt a Sign and an half, or is in the midſt of the firſt Quarter, it is in T *b*, the middle diſtance from the Earth; in the Quadrature or firſt Quarter, 'tis in the Perigée of the Eccentrick, and in the other half quarter it is again in T *d*, the middle diſtance from the Earth, till at the Full Moon it return to the Apogée in E. Likewiſe after the Full Moon, the Centre of the Epicycle comes to the Perigée of the Eccentrick, and about the New Moon it returns to the Apogée; ſo that in the whole Lunation it makes not a Circle, but a kind of Elliptick, or an Oval Line, ſuch as is ſhown in this and the following Scheme, by the Points A *b c d* E *f g h* A. And ſo at length it hence follows, that the diſtance of the Moon from the Apogée, for inſtance, B T *b*, is always double to its Elongation, or fartheſt departure from the Sun A T *b*. And whereas in the Sun, the diſtance of the Line of the middle Motion from the Line of the Apogée, is call'd the Anomaly or the Argument; here, in the Moon, it is called, not by the ſame, but a different Name, to wit, The Centre of the Moon. Now all that this ſecond, or monthly Inequality of the Moon does, is this; It makes the Centre of the Epicycle, twice in a Lunation, draw near the Earth, and makes it twice be removed farther from the ſame, as it plainly appears in Scheme V. Whence it happens, that the ſecond Inequality alone, without the Conſideration of the Epicycle, does nothing alter the Motion of the Moon's Longitude: For though the Centre of the Epicycle does, by ſuch a Motion, come ſometimes nearer to the Earth, and does again depart farther from it; yet the Angles A T *b*, A T *c*, (the ſpace of which it recedes from the Line of the middle Motion of the Sun,) are always increaſed equally; and ſo to our ſight, who are plac'd in T, the Centre of the Epicycle ſeems to move equally. Therefore hitherto we have been laying the Foundation for the ſecond Inequality, and have ſhown from whence it ariſes; though we cannot, as yet, underſtand the Effect of it, before we make uſe of an Epicycle; which, beſides receiving and drawing into it ſelf the Effects of the monthly Inequality, does alſo in its Gyration, or wheeling about, add another Inequality of its own, called the Abſolute, which I am now about to explain. Fig. V.

4. Now then in Scheme V. where there are the ſame Letters over again, that there were in the former, and they ſignifie the ſame; *viz.* A T E, the Line of the middle Motion of the Sun, *&c.* Now the Epicycle by the Motion of the Eccentrick above explain'd, obtains a various diſtance from the Earth T, and moreover it goes round by its own proper Motion, carrying about with it the Body of the Moon, ſometimes from *i*, towards K and *y*, ſometimes again from *y*, toward Z and *i*; whereby it happens, that the Moon does by this Inequality (which is call'd the firſt) depart from the Line of the middle Motion T A, ſometimes towards the ſide K, ſometimes toward Z; ſo that running through Fig. V. the upper part of the Epicycle Z *i* K, (which is the part far- Fig. V.

theſt from the Earth,) it is carried contrary to the order of the Signs, and ſo abates of its Motion. But on the other hand, being in the lower Semicircle of the Epicycle K y Z, which is neareſt the Earth, it is carried according to the Order of the Signs, and ſo its Motion is made ſwifter. And this Revolution of the Moon in the Epicycle, and the firſt Inequality which riſes from it, is perform'd neither in a Periodical month, nor a Synodical, but in a ſpace of time leſs than a Synodical one, but greater than a Periodical.

For whereas a Periodical Month is made up of twenty ſeven days, ſeven hours and 43′, and a Synodical one of twenty nine days, twelve hours and 44′; this Revolution of the Moon in the Epicycle is finiſh'd in twenty ſeven days, thirteen hours and almoſt 9′; and for this reaſon this Inequality is called the Abſolute, as being tied to no certain Configuration of the Moon with the Sun. For when, for inſtance at any new Moon, the Moon is in *i* the Apogée of the Epicycle, in the half Quarter it will be in *b*, diſtant from the Epicycle's middle Apogée K the Arch K L, but from the Epicycle's true Apogée *r* the Arch *r* L; K L indeed is call'd the middle Anomaly, or the middle Argument, but *r* L is the true; but the true Apogée of the Epicycle, is a Point in it very remote from the Earth, which ſhews the Right Line, drawn from the Earth T, thro' the Centre of the Epicycle: But now the middle Apogée of the Epicycle K, as ſhown by the right Line 6 *b* K, drawn through the Centre of the Epicycle from 6 the Point, that is oppoſite to the Centre of the Eccentrick when 'tis in 2. For in the *Syzygies* and Quarters of the Moon, the true Apogée of the Epicycle falls in with the middle Apogée; but in the times betwixt thoſe they vary from one another. Then the Centre of the Epicycle being mov'd on into *c*, the Moon will be in M in a Quarter, that is, ninety degrees remov'd from the Sun; and its middle Anomaly as well as its true will be I M. So the Centre of the Epicycle going on into *d*, the Moon will be in N, diſtant from the Epicycle's middle Apogée *m*, the Arch *m s* N, but from the true Apogée *s* the Arch *s* N. In oppoſition the Moon will be in O, diſtant from the middle, as well as true Apogée of the Epicycle *n*, the Arch *n* 12 O, which will be ſomething greater than a Semicircle: For the whole Epicycle runs round ſooner than the Lunation is compleated; and therefore in half a Lunation, the Epicycle makes more than a Semicircle: And ſo farther on you may obſerve the Courſe of the Moon in P Q R, till it be in X, at the end of its Lunation; namely, when in a Synodical Month it has run through the whole Epicycle, and the Arch *i x* beſides: And thence beginning another Month, *viz.* from X, it will paſs through the Points S T V X Y Z, 9, 10. Hence it is, that the Inequality that riſes from the Motion of the Epicycle is call'd Abſolute, becauſe when the Lunation is ended, the Moon does not return to the ſame Point of the Epicycle, from whence it did depart: But by the Elliptical Motion of the Epicycle, which is conſtantly finiſh'd in every Lunation, the Epicycle it ſelf does approach the Earth twice in every Month, and is twice remov'd farther from it: Wherefore it muſt needs be, that not only the whole Epicycle, but alſo its parts, and its Arches of Anomalies K L, L M, M N, muſt according to the different diſtance from the Earth, afford different Appearances of magnitude to thoſe that behold them from T, and ſo that departure of the Moon from the Apogée of the Epicycle, or from the Line of middle Motion, though it be in it ſelf the ſame, yet it muſt ſeem greater or leſs, according as the Epicycle is nearer to, or farther from the Eye. And thus the Motion of the Eccentrick, making ſuch an Approachment, and again ſuch a Retreat of the Epicycle, is the cauſe of the ſecond Inequality of the Moon, which is call'd the monthly: And the effect of the ſame we perceive in the Epicycle it ſelf, which for that reaſon appears ſometimes leſs, and and ſometimes greater, and ſo ſhews the Arch of the Moon's Digreſſion in like manner, ſometimes greater, and ſometimes leſs. But however the very Eye does without much difficulty diſcern, that the Epicycle, when in *c*, is ſeen under a greater Angle M T S, than if the ſame being plac'd in A, ſhould be ſeen under the Angle Z T K; and that the utmoſt Digreſſion of the Moon *l* T M ſeems greater there, than even the greateſt *i* T K does ſeem here. Now what is ſaid of variouſneſs of the greateſt Digreſſion, the ſame is likewiſe underſtood of any other Digreſſion whatever. But farther, the declining of the true Apogée of the Epicycle from the middle one, does alſo help the ſecond Inequality; by which it comes to paſs, that the Epicycle, about the time of Conjunction or oppoſition,

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coming from *b* by A to *b*, the middle Apogée *q* comes nearer and nearer to the true one *u*, untill it be joyn'd to it in *i*, and thence it runs beyond the true Apogée *r* into K, the Motion tending towards the Antecedent Signs, and so the same way that the Moon is carried; and therefore for this reason the Motion of the Moon in the Epicycle must needs be quicken'd: For seeing the Moon departs from the middle Apogée, as from a certain Goal, always with an equal swiftness, if the Goal it self, from whence the Motion is computed, do together with it go on towards the same place, the progress of the Moon must certainly be so much the more advanc'd, by how much the Goal helps it by its Motion. But it is true, that the contrary happens about the Quarters for the contrary reason, that is, before and after them the Motion of the Moon in the Epicycle is made slower. And now the Arch *r* K, or the Angle *r b* K, by which the middle Apogée differs from the true, is call'd the *Prosthaphæresis*, or the Equation of the Centre, and is equal to the Angle 6 *b* T. But the Angle *r* T L, that lies between the Lines of the middle Motion of the Moon *r* T, and of the true Motion of the same T L, (drawn from the Earth through the Body of the Moon,) is called the Equation of the Argument; and whereas there the *Prosthaphæresis* of the Centre is added to the middle Argument, that the true may be found; if the Centre of the Moon be less than six Signs; and is substracted, if it be greater: Here on the contrary, the Equation of the Argument is substracted, if the Centre of the Moon be lesser than six Signs; and is added, if it be greater.

5. But seeing 'tis usual in the old Astronomy to compute the Inequality of the Moon, and so of the other Planets, by excess and proportional Scruples, that the Reader may not be quite ignorant of this doctrine, let him take briefly thus: The Epicyclical *Prosthaphæreses*, as for instance *r* T L, by reason of the Epicycle's Approachment to the Earth, are increas'd, and so do admit of as many varieties as there are divers distances of the Epicycle it self from the Earth: But to go about to compute the *Prosthaphæreses* of the Moon as in every degree of the Epicycle, for so many diverse distances would be too troublesome and mad a piece of work: Therefore the Ancients computed the said *Prosthaphæreses* only for two distances of the Epicycle, to wit, the greatest and the least; whence were made the least of the Epicyclical *Prosthaphæreses*, belonging to the Moon, when in the Apogée of the Eccentrick, which *Prosthaphæreses* they laid down in Tables; but the greatest that were found by the same Computation, which belong to the Situation of the Epicycle in the Perigée, they did not draw up in Tables, but they put down the differences, whereby these exceeded the least, by the name of Excess, divided into sixty Scruples. Then to any distance of the Epicycle from the Earth they added proportional Scruples, which shew how much of the whole Excess, or rather Increase of the *Prosthaphæreses* was owing to such or such a Situation of the Epicycle between the farthest and the nearest. For the proportional Scruples being brought into the whole Excess, out of them came a portion to be added to every *Prosthaphæresis* of the Epicycle in the Apogée, that so may come a just *Prosthaphæresis* for such a distance of the Epicycle from the Earth. And thus have I laid down what seem'd requisite, of *Ptolomy's* Theory of the Moon.

6. The other *Phænomenon*, wherein the Moon appears to depart from the *Æquator* sometimes more, and sometimes less than the Sun does, is explain'd by the Motion of Latitude: For as the way of the Sun, or the Ecliptick, does cut the *Æquator* obliquely in the two opposite Equinoctial Points, so the way of the Moon or the Eccentrick which it moves in, does not directly lie under the Ecliptick, but cuts it obliquely in two opposite Points, call'd Nodes or Knots; and that is nam'd the Ascendent, by which it passes from South and North; and that the Descendent, by which it passes from North to South: And therefore it comes, that the Moon, in moving in its Orbit or way, is found twice in the Ecliptick in every Period or Revolution of it; namely, when it is in the Nodes. At all other times, it is distant from it more or less: For its greatest Digression happens about ninety degrees from the Nodes as may be understood from this Figure VI; where ☊ is the Ascendent Node, or the Dragon's Head, ☋ the Descendent Node, or the Dragon's Tail; ☊ B, ☋ A, the Orbit of the Moon, ☊ E, ☋ the Ecliptick, B the Northern Bound, A the Southern. Now the distance of the Moon from the Ecliptick, taken in the Circle of Latitude, that is Fig. VI.

drawn

drawn perpendicular through the body of the Moon to the Eclipticks, is call'd the Latitude of the Moon; which, when greatest, is of five degrees. But here 'tis to be noted by the way, That the Nodes of the Moon are not fixt in any certain Points of the Ecliptick, but do go on by little and little towards the Antecedent Signs, every day some little more than three Minutes, so within almost nineteen years they go their round.

Now this Theory of the Moon, which I have now explained, is still but lame and defective, upon several Accounts. Later Ages have indeed, in a great measure, mended its Imperfections; but yet one thing above all the rest seems to be intolerable in it, That in the Quarters, it makes the Moon be too near the Earth; whereby the apparent Magnitude of the Moons Diametre would, about those times, become almost as big again as in the *Syzygies*; which even the Vulgar themselves know to be false.

CHAP. V.

Of the Phases, *or the Appearances of the Moon.*

THE Moon is an Opaque, or thick and dark Body, and does in no wise let the Rays, which it receives from the Sun, pass through it, but reflects them back again, as the Earth does: And farther, seeing it is of a Spherical or round Figure, no more than about the half, or little more, is enlightned by the Sun; and the other part, which is turn'd from the Sun, is in Darkness, and does not cast any Light to our Eyes, except perhaps some faint kind of Light, about the New Moon especially. But as the Rays that come from the Sun, and fall upon the Moon, do distinguish the enlightened Hemisphere from the Opaque; so again, The Rays that go from our Eyes to the same Globe of the Moon, do distinguish the visible Hemisphere, or half of the Moon, from that which is not seen. If therefore it so happen, that the Rays that go both from the Sun, and from our Eye, do fall upon the Moon on the same side, then the enlighten'd Hemisphere must needs be the same with that which is visible; since the Sun and the Eye do look upon the Moon from the same parts, or on the same side, as I said, and then the Full Moon appears to us. But on the contrary, when the Moon is plac'd in the midst, between the Sun and our Eye, it happens, That the Hemisphere that is enlighten'd by the Sun, is to us invisible; but the other Opaque Hemisphere that is turn'd from the Sun, is then towards us; and then the Moon is not taken out of the Heavens, but to our Eyes dis-appears; at which time is that which we call the New Moon, or the space between one Moon and another, or the thirsty Moon. It may also happen, that not the whole enlighten'd Hemisphere may be seen by us, as 'tis in the Full Moon; nor the whole Opaque Hemisphere be turn'd towards us, as 'tis in the New Moon; but part of the enlighten'd, with part of the Opaque, may be turn'd towards us, as 'tis at the times between the Change and Full, and then the Moon shines not with an whole Hemisphere, but with a greater or less part of it, according as less or more of that which is enlighten'd does offer it self to our Sight: And hence are all these different *Phases* of the Moon, which appears horned, then an Half Moon, then bunching out on each side, and then a Full Moon, as may be seen

VII. in Scheme VII. where the Moon running through its Orb, from the time of its Conjunction with the Sun, does successively appear such as it is here represented by those parts of the Circle that are left white. And the Cause of these

VIII. *Phases* may in some measure be understood from Scheme VIII. while the Moon goes about the Earth, the Sun does continually enlighten one half of it; but of that half sometimes more, and sometimes less, and sometimes none at all, is turn'd towards us. And the Semicircles that are turn'd toward the Earth, or toward the Eye, are to be conceiv'd as if they were half Globes; and the bending which cannot be represented in a Plain, is to be supplyed by Imagination. Now here three things especially are to be observ'd; First, That the

Fig. I.

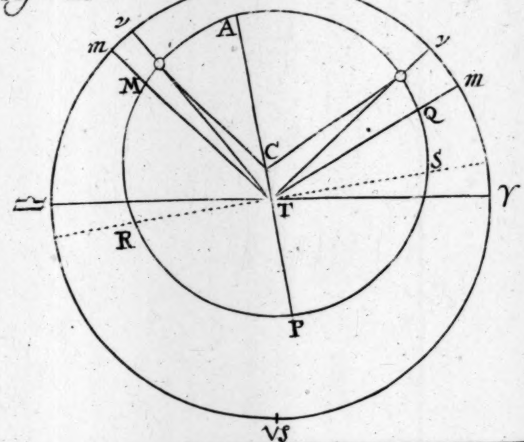
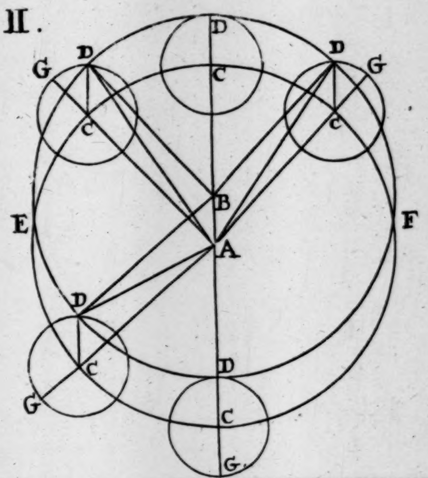


Fig. II.



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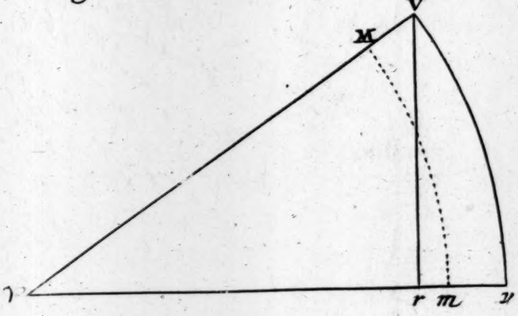

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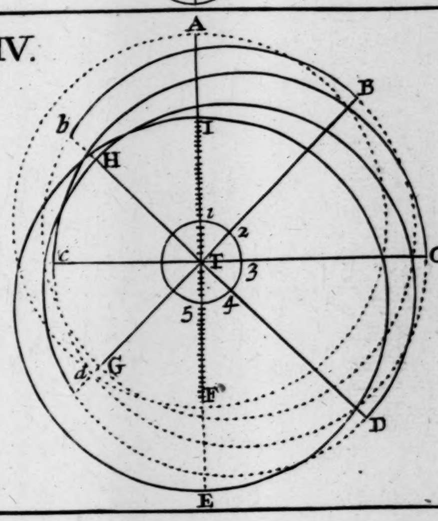


Fig. V.

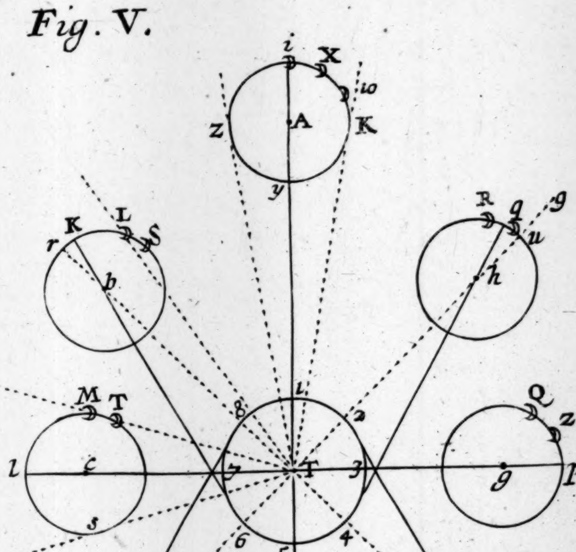


Fig. VI.

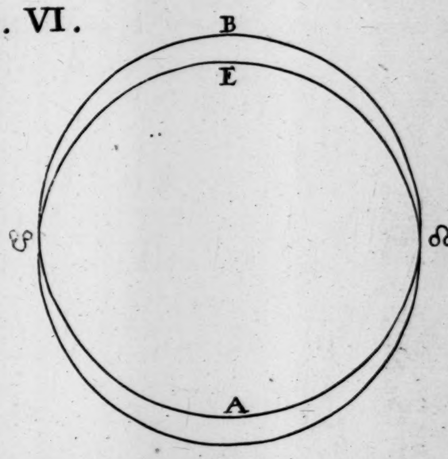
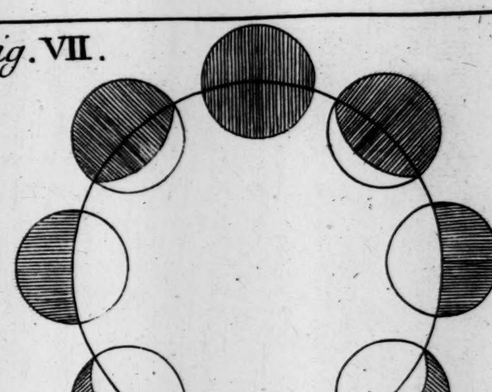


Fig. VII.



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ſame ſide of the Moon is always towards our Eyes, which is prov'd by the Spots of the Moon, which always appear to be the ſame. For if ſometimes one, and ſometimes another ſide of the Moon ſhould be towards us, different Spots would ſurely appear. Some indeed object, That this can in no wiſe conſiſt with the Motion of the Moon in the Epicycle; For in Scheme XXX. while the Centre of the Epicycle comes from A, through *b*, *c*, *d*, to E; if the Epicycle ſhould be depriv'd of its proper Motion about its own Centre, and the Moon that is fixt in it be in *i*, the Moon would be carried, together with the Epicycle, into *n*; and the Parts, as well of the Epicycle, as of the Moon, which in A were turn'd to or from the Earth T, the ſame would alſo be turn'd to or from it in E: But if the Epicycle ſhould moreover be conceiv'd to roll about in the mean time, with the Body of the Moon fixt in it, from *n* through 12 to O; then truly that part of the Moon, which being in *n*, was turn'd from the Eye plac'd in T, the ſame being in O would be turn'd from it, and ſo contrariwiſe. But the Anſwer to this is eaſie; For 'tis but ſuppoſing the Body of the Moon to be mov'd about its own Centre, that it may be as much turn'd towards the Earth by its own Motion, as by the Motion of the Epicycle it is turn'd away from it. Fig. XXX.

Fig. VIII. The ſecond thing to be obſerved is, That the Moon does firſt of all appear with very ſmall Horns, ſometimes one day, ſometimes two days, and ſometimes not till three days from the time of its Conjunction or Change: And the ſame may be ſaid of its hiding itſelf before its Conjunction; of which three Cauſes may be aſſign'd. The firſt is the ſlowneſs or ſwiftneſs of the Moon's Motion: For with that part of the Epicycle, which is towards the Earth, the Body of the Moon tends towards the Conſequent Signs, and ſo the ſame way that the Centre of the Epicycle does; whereby its Motion is made more ſwift. The contrary happens, when the Moon, being in that part of the Epicycle which is fartheſt from the Earth, moves againſt the order of the Signs, and ſo takes off from the Motion, by which the Centre of the Epicycle does continually move into the Signs Conſequent. Now, by how much the Moon moves the faſter, ſo much the ſooner does it depart from the Sun, and ſhew its Horns. Another Cauſe is the Moons being plac'd in Signs of long or ſhort Aſcenſions or Deſcenſions: For when the New Moon is in Signs of long Aſcenſions, namely, ♑, ♒, ♓, ♈, ♉, ♊; then the degrees of the Ecliptick, that are between the Sun and the Moon, are longer in going down, and make the Moon ſtay longer above the Horizon after Sun-ſet; and ſo it gets out of the Twilight the ſooner, from the Time of its Change, ſo as that it may be ſeen. In like manner, the Old Moon being in the Signs of long Aſcenſions, ♋, ♌, ♍, ♎, ♏, ♐, ariſes the earlier before the Sun; and ſo, though it be near the Conjunction, yet however it is ſeen. The contrary happens to the New Moon, when in Signs of ſhort Aſcenſions; and to the Old Moon, when in Signs of ſhort ones. The third Cauſe is the Northern or Southern Latitude of the Moon: For in the Northern Hemiſphere of the Earth, by how much the Moon is more North, ſo much the ſooner does it ariſe before the Sun, and ſets the later after it; whereby again, it is the ſooner ſeen, when 'tis New; and the longer when 'tis Old. But it happens to the contrary, when it is more South. Fig. VIII.

The third Thing worth Obſervation, is that faint kind of Light, which beſides its Silver Horns, appears both in the New and the Old Moon, and makes the reſt of its Hemiſphere viſible: 'Tis call'd its ſecondary Light, and is commonly thought to be the Native Light of the Moon. But 'tis to be obſerv'd, That it is owing to the Earth, which reflects towards the Sun, and the neighbouring Region, the Rays that it receives from it. When therefore the Moon, about the time of its Conjunction, is within that Region, it partakes of that Reflected Light: But does not ſo, when it is remov'd from the Sun more than a Quarter, or 90 Degrees: And ſo it being too far out of the Region of Reflexion, that faint Light now ſpoken of vaniſhes.

CHAP.

CHAP. VI.

Of the Eclipse of the Moon.

1. THE Greek word *Eclipsis* denotes a defect or want of Light, which in the Moon is real, for as much as it has no Light of its own; wherefore the Earth coming between the Sun and it, the Rays must needs be intercepted, whereby otherwise it is wont to be enlighten'd: For the Earth is an opaque Body, that casts a shadow from it, which when the Moon falls into, it is darken'd. Now the shadow of the Earth does not extend it self beyond the Region of the Moon, because no other Star or Planet is found to fall into it, to suffer such a defect; whence it manifestly follows, that the Sun must be greater than the Earth; for if it was equal, the shadow of the Earth would be cylindrical, as in Scheme IX. or if the Sun was less than the Earth, its shadow would be found to be Calathoide, or of the Form of a Basket, growing wider and wider from the Top downwards, as in Scheme X. And either way the shadow would reach *in infinitum*, whereby other Planets also would sometimes be involv'd in it. But it is Conical or like a Top, such as it appears in Scheme XI.

Fig. IX.
Fig. X.
Fig. XI.

2. But farther hence it may be understood, that seeing the Sun moves perpetually under the Ecliptick; therefore its shadow must always fall upon the opposite Point of the Ecliptick: Wherefore if the Moon should constantly move, as the Sun does, under the Ecliptick, it would necessarily suffer an Eclipse every full Moon, when it came into that Point of the Ecliptick, that is opposite to the Sun, and is within the shadow of the Earth. But it was said in the Theory of the Moon, that it walks in a Circle, that inclines obliquely to the Sun's way, and passes the Ecliptick onely twice every Month; when therefore the Sun is far from the Nodes of the Moon, then also the Moon, that is opposite to it, is as far remov'd from them, and so has a Latitude or distance from the Ecliptick, greater than that it can come under the shadow that lies there. Yet because the Sun passes through the whole Zodiack by its yearly Motion, it must needs in that time come to both the Nodes of the Moon, little less than six Months always being spent between its coming to the Ascendent and the Descendent Node. And though the full Moon does not continually happen at the very same moment of the Sun's coming to the Node, yet the Moon can scarce escape the shadow, which is so broad, that though the Full Moon be more than ten days distant from the meeting of the Sun and of the Node; yet the Moon is not then gotten so far from the Ecliptick, as to escape untouch'd. But yet if the meeting of the Sun and of the Node, happen to be at the New-Moon, or a day either before or after; then both the foregoing and following Full Moon will be so far from thence, that it will clearly avoid an Eclipse. Now by how much the farther the Full Moon is from the Nodes, so much less of the shadow will it fall under; whence it comes, that some Eclipses of the Moon are Total, which happen either in the very Node, or something near it; others are only partial, and so much the less, by how much they happen the farther from the Nodes. Besides, the Moon's distance from the Earth, which is sometimes greater and sometimes less, is the cause why Eclipses appear sometimes less, and greater than they do at other times; for the Cone of the shadow growing smaller and smaller, till it come into a Point, therefore the farther it is extended from the Earth, the slenderer it grows: Wherefore the Moon in the Apogée, has a shadow to pass thorow, that is not so thick as that it has in its Perigée, and so it is less obscur'd. Moreover the Motion of the Moon being sometimes swifter and sometimes slower, is the reason why it passes thorow the shadow the sooner, or stays the longer in it. Again, a total Eclipse is Central, when the Full Moon happens to be in the very Node, as in Figure XII. where A B is the Ecliptick, C D the Orbit of the Moon, E the Moon first entring into the shadow, F the Motion going out again, G the Moon in the very Centre of the shadow. But now a Non-central, though a total one, may be understood by Figure XIII. where the Centre of the Shadow, at the time of the greatest Obscuration, is not of the Node H, but out of it.

Fig. XII.
Fig. XIII.

But

But before I come to that, you may perceive by the XII Figure, that Central Eclipses, that are of the greatest duration, can scarce last a few Minutes above four Hours: For seeing the Moon, in the time from the beginning of its Obscuration to the end, does with its Centre go through the Line E F, which is equal almost to four Moons, (now the Moon takes up in the Heavens about half a degree,) therefore E F will be about two degrees. Now the Motion of the Moon for every hour is almost half a degree above the Sun, (and so above the Shadow;) wherefore the Moon will go through those two Degrees in about four hours time. And when the total Immersion of the Moon into the Shadow happens in H, and the first Recovery of Light in I, so that H I is the space the Moon has to pass, while it stays in total Darkness; and seeing H I is almost the half of the whole Line E F; hence it comes to pass, that half the Duration, in this Instance two hours, is the time of the Moon's stay in total Darkness: For the time of Incidence, while the Moon goes from E to H, from the beginning of the Eclipse to the very Moment of its Immersion, or total Obscuration, is but about an Hour; and the time of Regress, while it goes from I to F, from the Moment of its first Emersion, or Recovery of Light, to the very End of the Eclipse, is about the same. And now as for a partial Eclipse, it may be understood from one or two Schemes following. The Orbit or way of the Moon, is represented double in each of them, that it may be understood, why an Eclipse happens sometimes towards the South, and sometimes towards the North. Now Fig. XIV. shews, how the Moon may sometimes chance to be eclips'd, before it come to the Node; but Fig. XV. how it may be so, after it have pass'd it; which Things are likewise to be supplyed about Fig. XIII. which is of Eclipses that are total, but not central. And now the Diametre of the Moon being suppos'd to be divided into twelve equal parts, which they call Digits, the quantity of the Eclipse, or want of Light, is wont to be represented by Digits, (and also by minutes of Digits, and is accounted greater, or less, according as the Obscuration is, of more or fewer Digits.

Fig. XII. Fig. XIV. Fig. XV. Fig. XIII.

But besides all these, there are found in the Moon, when eclips'd, two *Phænomena* more; namely, a faint kind of Shadow, call'd a *Penumbra*, or the utmost Edge of the Shadow, something less obscure than the rest; and a certain reddish colour'd Light, that the Moon shews out of the very Darkness, and which, in total Eclipses especially, is so much the redder and obscurer, by how much the Moon comes the more towards the Axle or Centre of the Shadow. As for the *Penumbra*, the Cause of it is plain enough; because the Earth going under the Sun by little and little, at first only part of the Sun is taken from the Moon, but that by degrees grows greater and greater. Now that part of the Moon from whom more parts of the Sun are hidden, must needs be involv'd in the thicker Darkness; wherefore the *Penumbra* towards the perfect Shadow, does, by little and little, grow more and more obscure: But now, as for the reddish Light that appears out of perfect Darkness, which is by some thought to be the Moon's own native Light, seems rather to arise from the Refraction of the Sun's Rays, that pass through the Earth's Atmosphere, or Shpere of Vapours; and that decline towards the Axle of the Shadow, and that temper the Shadow with a kind of Twilight, more about the outmost Edges, less towards the Centre or Axle, whither few or no Rays are reflected; by which the Moon becomes scarce, or not scarce visible.

CHAP. VII.

Of the Eclipse of the Sun.

THAT which is called an Eclipse of the Sun, might more fitly be called an Eclipse of the Earth: For it is the Earth that is then depriv'd of the Light of the Sun by the Moon's coming between; just as the Moon when eclips'd, is depriv'd of it by the Earth's coming between it and the Sun: whereas

drawn perpendicular through the body of the Moon to the Ecliptick, is call'd the Latitude of the Moon; which, when greatest, is of five degrees. But here 'tis to be noted by the way, That the Nodes of the Moon are not fixt in any certain Points of the Ecliptick, but do go on by little and little towards the Antecedent Signs, every day some little more than three Minutes, so within almost nineteen years they go their round.

Now this Theory of the Moon, which I have now explained, is still but lame and defective, upon several Accounts. Later Ages have indeed, in a great measure, mended its Imperfections; but yet one thing above all the rest seems to be intolerable in it, That in the Quarters, it makes the Moon be too near the Earth; whereby the apparent Magnitude of the Moons Diametre would, about those times, become almost as big again as in the *Syzygies*; which even the Vulgar themselves know to be false.

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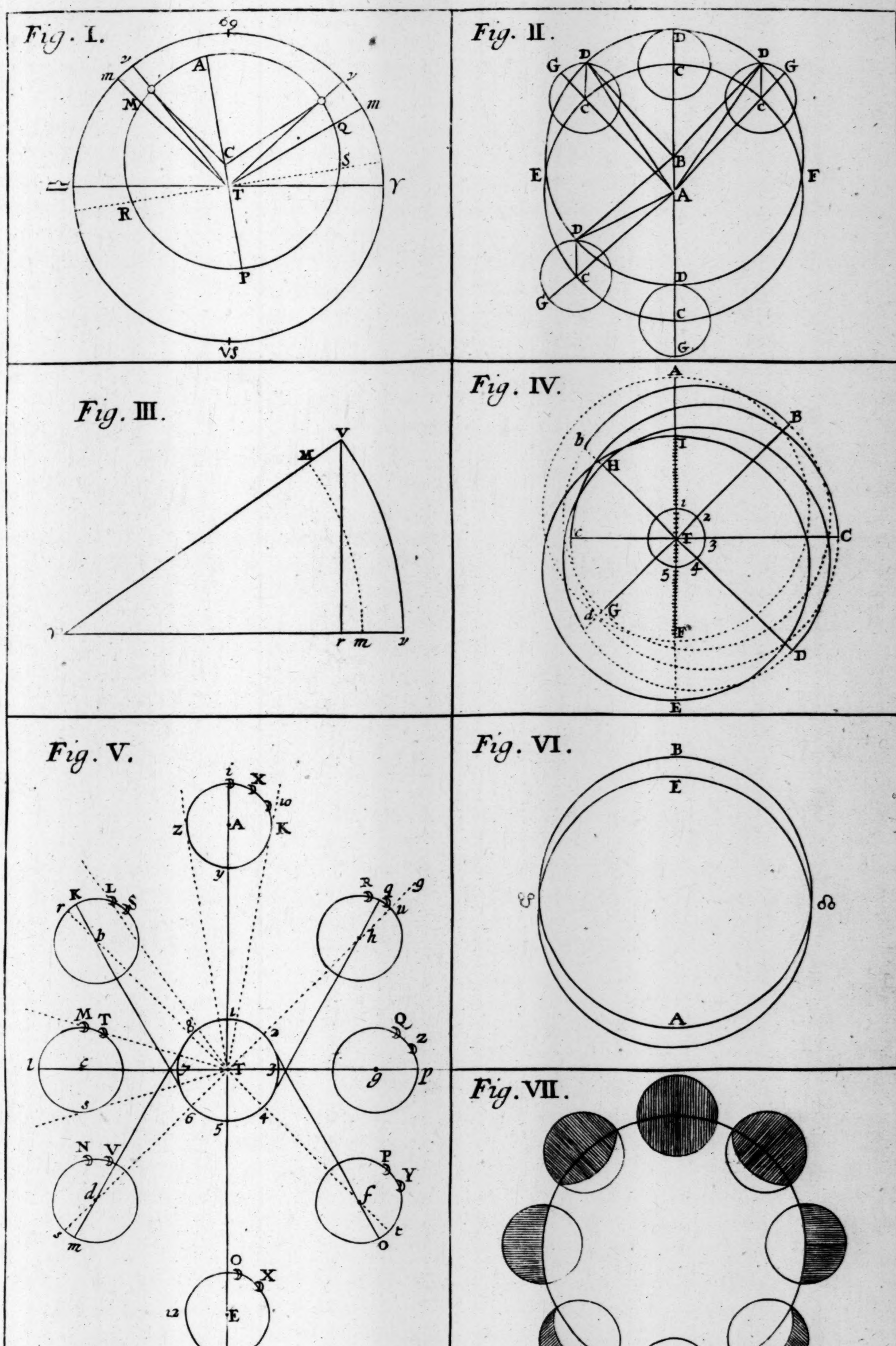

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ſame ſide of the Moon is always towards our Eyes, which is prov'd by the Spots of the Moon, which always appear to be the ſame. For if ſometimes one, and ſometimes another ſide of the Moon ſhould be towards us, different Spots would ſurely appear. Some indeed object, That this can in no wiſe conſiſt with the Motion of the Moon in the Epicycle; For in Scheme XXX. while the Centre of the Epicycle comes from A, through *b*, *c*, *d*, to E; if the Epicycle ſhould be depriv'd of its proper Motion about its own Centre, and the Moon that is fixt in it be in *i*, the Moon would be carried, together with the Epicycle, into *n*; and the Parts, as well of the Epicycle, as of the Moon, which in A were turn'd to or from the Earth T, the ſame would alſo be turn'd to or from it in E: But if the Epicycle ſhould moreover be conceiv'd to roll about in the mean time, with the Body of the Moon fixt in it, from *n* through 12 to O; then truly that part of the Moon, which being in *n*, was turn'd from the Eye plac'd in T, the ſame being in O would be turn'd from it, and ſo contrariwiſe. But the Anſwer to this is eaſie; For 'tis but ſuppoſing the Body of the Moon to be mov'd about its own Centre, that it may be as much turn'd towards the Earth by its own Motion, as by the Motion of the Epicycle it is turn'd away from it. Fig. XXX.

Fig. VIII. The ſecond thing to be obſerved is, That the Moon does firſt of all appear with very ſmall Horns, ſometimes one day, ſometimes two days, and ſometimes not till three days from the time of its Conjunction or Change: And the ſame may be ſaid of its hiding itſelf before its Conjunction; of which three Cauſes may be aſſign'd. The firſt is the ſlowneſs or ſwiftneſs of the Moon's Motion: For with that part of the Epicycle, which is towards the Earth, the Body of the Moon tends towards the Conſequent Signs, and ſo the ſame way that the Centre of the Epicycle does; whereby its Motion is made more ſwift. The contrary happens, when the Moon, being in that part of the Epicycle which is fartheſt from the Earth, moves againſt the order of the Signs, and ſo takes off from the Motion, by which the Centre of the Epicycle does continually move into the Signs Conſequent. Now, by how much the Moon moves the faſter, ſo much the ſooner does it depart from the Sun, and ſhew its Horns. Another Cauſe is the Moons being plac'd in Signs of long or ſhort Aſcenſions or Deſcenſions: For when the New Moon is in Signs of long Aſcenſions, namely, ♑, ♒, ♓, ♈, ♉, ♊; then the degrees of the Ecliptick, that are between the Sun and the Moon, are longer in going down, and make the Moon ſtay longer above the Horizon after Sun-ſet; and ſo it gets out of the Twilight the ſooner, from the Time of its Change, ſo as that it may be ſeen. In like manner, the Old Moon being in the Signs of long Aſcenſions, ♋, ♌, ♍, ♎, ♏, ♐, ariſes the earlier before the Sun; and ſo, though it be near the Conjunction, yet however it is ſeen. The contrary happens to the New Moon, when in Signs of ſhort Aſcenſions; and to the Old Moon, when in Signs of ſhort ones. The third Cauſe is the Northern or Southern Latitude of the Moon: For in the Northern Hemiſphere of the Earth, by how much the Moon is more North, ſo much the ſooner does it ariſe before the Sun, and ſets the later after it; whereby again, it is the ſooner ſeen, when 'tis New; and the longer when 'tis Old. But it happens to the contrary, when it is more South. Fig. VIII.

The third Thing worth Obſervation, is that faint kind of Light, which beſides its Silver Horns, appears both in the New and the Old Moon, and makes the reſt of its Hemiſphere viſible: 'Tis call'd its ſecondary Light, and is commonly thought to be the Native Light of the Moon. But 'tis to be obſerv'd, That it is owing to the Earth, which reflects towards the Sun, and the neighbouring Region, the Rays that it receives from it. When therefore the Moon, about the time of its Conjunction, is within that Region, it partakes of that Reflected Light: But does not ſo, when it is remov'd from the Sun more than a Quarter, or 90 Degrees: And ſo it being too far out of the Region of Reflexion, that faint Light now ſpoken of vaniſhes.

CHAP.

CHAP. VI.

Of the Eclipse of the Moon.

1. THE Greek word *Eclipsis* denotes a defect or want of Light, which in the Moon is real, for as much as it has no Light of its own; wherefore the Earth coming between the Sun and it, the Rays must needs be intercepted, whereby otherwise it is wont to be enlighten'd: For the Earth is an opaque Body, that casts a shadow from it, which when the Moon falls into, it is darken'd. Now the shadow of the Earth does not extend it self beyond the Region of the Moon, because no other Star or Planet is found to fall into it, to suffer such a defect; whence it manifestly follows, that the Sun must be greater than the Earth; for if it was equal, the shadow of the Earth would be cylindrical, as in
Fig. IX. Scheme IX. or if the Sun was less than the Earth, its shadow would be found to be Calathoide, or of the Form of a Basket, growing wider and wider from the
Fig. X. Top downwards, as in Scheme X. And either way the shadow would reach *in infinitum*, whereby other Planets also would sometimes be involv'd in it. But it
Fig. XI. is Conical or like a Top, such as it appears in Scheme XI.

2. But farther hence it may be understood, that seeing the Sun moves perpetually under the Ecliptick; therefore its shadow must always fall upon the opposite Point of the Ecliptick: Wherefore if the Moon should constantly move, as the Sun does, under the Ecliptick, it would necessarily suffer an Eclipse every full Moon, when it came into that Point of the Ecliptick, that is opposite to the Sun, and is within the shadow of the Earth. But it was said in the Theory of the Moon, that it walks in a Circle, that inclines obliquely to the Sun's way, and passes the Ecliptick onely twice every Month; when therefore the Sun is far from the Nodes of the Moon, then also the Moon, that is opposite to it, is as far remov'd from them, and so has a Latitude or distance from the Ecliptick, greater than that it can come under the shadow that lies there. Yet because the Sun passes through the whole Zodiack by its yearly Motion, it must needs in that time come to both the Nodes of the Moon, little less than six Months always being spent between its coming to the Ascendent and the Descendent Node. And though the full Moon does not continually happen at the very same moment of the Sun's coming to the Node, yet the Moon can scarce escape the shadow, which is so broad, that though the Full Moon be more than ten days distant from the meeting of the Sun and of the Node; yet the Moon is not then gotten so far from the Ecliptick, as to escape untouch'd. But yet if the meeting of the Sun and of the Node, happen to be at the New-Moon, or a day either before or after; then both the foregoing and following Full Moon will be so far from thence, that it will clearly avoid an Eclipse. Now by how much the farther the Full Moon is from the Nodes, so much less of the shadow will it fall under; whence it comes, that some Eclipses of the Moon are Total, which happen either in the very Node, or something near it; others are only partial, and so much the less, by how much they happen the farther from the Nodes. Besides, the Moon's distance from the Earth, which is sometimes greater and sometimes less, is the cause why Eclipses appear sometimes less, and greater than they do at other times; for the Cone of the shadow growing smaller and smaller, till it come into a Point, therefore the farther it is extended from the Earth, the slenderer it grows: Wherefore the Moon in the Apogée, has a shadow to pass thorow, that is not so thick as that it has in its Perigée, and so it is less obscur'd. Moreover the Motion of the Moon being sometimes swifter and sometimes slower, is the reason why it passes thorow the shadow the sooner, or stays the longer in it. Again, a total Eclipse is Central,
Fig. XII. when the Full Moon happens to be in the very Node, as in Figure XII. where A B is the Ecliptick, C D the Orbit of the Moon, E the Moon first entring into the shadow, F the Motion going out again, G the Moon in the very Centre of the shadow. But now a Non-central, though a total one, may be un-
Fig. XIII. derstood by Figure XIII. where the Centre of the Shadow, at the time of the greatest Obscuration, is not of the Node H, but out of it.

But

But before I come to that, you may perceive by the XII Figure, that Central Eclipses, that are of the greatest duration, can scarce last a few Minutes above four Hours: For seeing the Moon, in the time from the beginning of its Obscuration to the end, does with its Centre go through the Line E F, which is equal almost to four Moons, (now the Moon takes up in the Heavens about half a degree,) therefore E F will be about two degrees. Now the Motion of the Moon for every hour is almost half a degree above the Sun, (and so above the Shadow;) wherefore the Moon will go through those two Degrees in about four hours time. And when the total Immersion of the Moon into the Shadow happens in H, and the first Recovery of Light in I, so that H I is the space the Moon has to pass, while it stays in total Darkness; and seeing H I is almost the half of the whole Line E F; hence it comes to pass, that half the Duration, in this Instance two hours, is the time of the Moon's stay in total Darkness: For the time of Incidence, while the Moon goes from E to H, from the beginning of the Eclipse to the very Moment of its Immersion, or total Obscuration, is but about an Hour; and the time of Regress, while it goes from I to F, from the Moment of its first Emersion, or Recovery of Light, to the very End of the Eclipse, is about the same. And now as for a partial Eclipse, it may be understood from one or two Schemes following. The Orbit or way of the Moon, is represented double in each of them, that it may be understood, why an Eclipse happens sometimes towards the South, and sometimes towards the North. Now Fig. XIV. shews, how the Moon may sometimes chance to be eclips'd, before it come to the Node; but Fig. XV. how it may be so, after it have pass'd it; which Things are likewise to be supplyed about Fig. XIII. which is of Eclipses that are total, but not central. And now the Diametre of the Moon being suppos'd to be divided into twelve equal parts, which they call Digits, the quantity of the Eclipse, or want of Light, is wont to be represented by Digits, (and also by minutes of Digits, and is accounted greater, or less, according as the Obscuration is, of more or fewer Digits.

Fig. XII. Fig. XIV. Fig. XV. Fig. XIII.

But besides all these, there are found in the Moon, when eclips'd, two *Phænomena* more; namely, a faint kind of Shadow, call'd a *Penumbra*, or the utmost Edge of the Shadow, something less obscure than the rest; and a certain reddish colour'd Light, that the Moon shews out of the very Darkness, and which, in total Eclipses especially, is so much the redder and obscurer, by how much the Moon comes the more towards the Axle or Centre of the Shadow. As for the *Penumbra*, the Cause of it is plain enough; because the Earth going under the Sun by little and little, at first only part of the Sun is taken from the Moon, but that by degrees grows greater and greater. Now that part of the Moon from whom more parts of the Sun are hidden, must needs be involv'd in the thicker Darkness; wherefore the *Penumbra* towards the perfect Shadow, does, by little and little, grow more and more obscure: But now, as for the reddish Light that appears out of perfect Darkness, which is by some thought to be the Moon's own native Light, seems rather to arise from the Refraction of the Sun's Rays, that pass through the Earth's Atmosphere, or Shpere of Vapours; and that decline towards the Axle of the Shadow, and that temper the Shadow with a kind of Twilight, more about the outmost Edges, less towards the Centre or Axle, whither few or no Rays are reflected; by which the Moon becomes scarce, or not scarce visible.

CHAP. VII.

Of the Eclipse of the Sun.

THAT which is called an Eclipse of the Sun, might more fitly be called an Eclipse of the Earth: For it is the Earth that is then depriv'd of the Light of the Sun by the Moon's coming between; just as the Moon when eclips'd, is depriv'd of it by the Earth's coming between it and the Sun: whereas the

the Sun all the while keeps its Light untouch'd and unobscur'd; yet the Sun is said to suffer an Eclipse, in as much as with respect to us it does so. And here, that the Sun is to us Eclips'd, by reason of the Moon's putting between us and the Sun, is manifest even from this, That it is not eclips'd but at New-Moons, or when the Moon is in Conjunction with it. But that it is not eclips'd every New-Moon, the Reason is the Moon's Latitude; because of which it is, that the Moon passes by either higher towards the North, or else lower towards the South, and does not pass directly between us and the Sun: But that happens when the two Luminaries are about the same Node, and that not much above half a Sign from it. And let no one wonder, that there happen far more Eclipses of the Moon than of the Sun; for the Globe of the Moon being much less than the Globe of the Earth, it casts a less shadow: And again, The place of our Habitation is a great deal less than the whole Globe of the Moon; and so consequently the greater shadow (*viz.* of the Earth) does the more easily fall upon some part of the greater space, (*viz.* of the whole Moon,) than the lesser shadow (of the Moon) can fall upon the lesser space of our Habitation. But now this must be understood of some determinate place of the Earth, for instance, of this in which we now live; for otherwise, if we consider the whole Hemisphere of the Earth, (or the half of its Surface, taken for a Plain,) there are more frequent Eclipses of the Sun, than of the Moon: For every six, (and sometimes every five Months) there happen some, either here, or in some other parts of the Earth; nay, when there happen any Central Eclipses of the Moon, the New-Moon, both before and after, is for the most part made remarkable for some little Eclipse of the Sun: The reason of which is the great Bulk of the Earth, and the great nearness of the Moon; which, though it cast no great shadow, yet it threatens the Earth with a *Penumbra*, or faint shadow, that is so much the greater, by how much it is the nearer; which that it should fall upon some part or other of the Earth, is no wonder. But besides, the same Bulk of the Earth causes, That in some places there is a Total Eclipse of the Sun, while in others there is only a partial One, and in others none at all, as may be understood from Scheme XVI. where *a* is the Sun, *b* the Earth, *c* the Moon, *f b g* the Cone of the Moon's shadow, whose Base is the Hemisphere of the Moon *f g*; *h o l* is the other Cone of the Moon's *Penumbra*, whose Base is part of the Surface of the Earth *h l*. Now I say, That that little space of Earth *i k*, which falls under the perfect shadow of the Moon, will see a Total Eclipse of the Sun; since a right Line can be drawn from no point between *i* and *k* to any part of the Sun's Hemisphere, but it will be intercepted by the Body of the Moon *f c g*. Again, They that live between *i h* and *k l*, will have a partial Eclipse of the Sun, and that so much the greater, by how much they are nearer to *i* and *k*; but so much the less, by how much they are the farther off towards *h* and *l*. Lastly, They that dwell between *h m* and *l n*, will behold the whole Hemisphere of the Sun, eclips'd in no part of it. This Diversity also of Sight arises from the nearness of the Moon, which if farther off, and near the Body of the Sun, would cover it alike from all the Inhabitants of the Earth. And here by the way, we may in some measure take Notice of the nature of Parallaxes, (for so that Diversity of Sight is call'd;) namely, That they are owing, as to the Bulk of the Earth, so to the nearness of the Moon too: I design to explain them something more largely in the following Chapter. Now as for the Quantity of a partial Eclipse of the Sun, like that of the Moon, it is wont to be estimated or measured by Digits, or by twelve parts of the Sun's Diametre; and as for a Total Eclipse of the Sun, there is this difference between it and a Total Eclipse of the Moon, *viz.* That such an Eclipse of the Moon is generally of some remarkable Duration, since the Moon by its own Motion cannot in a little time free it self from the shadow of the Earth; but a Total Eclipse of the Sun cannot be of any long continuance, at least, not to be very sensible: And so neither can that Darkness be very long, that sometimes happens to be very thick at Noon-day, so that the Stars are seen, the Birds hide themselves, or else fall down; because the Moon by its own Motion running underneath the Sun, towards the East, as soon as by its Eastern Verge or Edge it is come to the Sun's Eastern Verge, and so covers the

Fig. XVI.

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Of Parallax.

HAving thus far been explaining the *Phænomena* of the Sun and Moon, that may be salv'd by the *Hypotheses* of the Ancients: There remain still two other *Phænomena*, to wit, the Parallaxes and Refractions, the Efficient Cause of which is not to be ascrib'd to any *Hypotheses* or Circles, but they depend wholly upon optick Grounds and Reasons. Now therefore as to Parallaxes, I have said already, that they are most observable in Eclipses of the Sun, and are owing to the Bulk of the Earth, and the nearness of the Planet. For though the whole Globe of the Earth, with respect to that vast and almost unmeasurable and infinite Expansion, and compass of the highest Heavens, be but like a Point, so that the fix'd Stars are by us observ'd, and to us appear no otherwise from the Earth's Surface, than if our Eye was plac'd in the Centre of the Earth; yet we must conclude otherwise with respect to the Sun and the Moon, the latter especially, whose nearness begets some diversity of sight, which the Greeks have call'd a Parallax. For the Bulk and Thickness of the Earth do make the Sun and Moon seem to have another position in the Heavens, than they really have with respect to the Centre of the Earth: Wherefore the Parallax may be thus describ'd; that it is the difference between the true and the visible, or seeming place of any Star. Now the true place of a Star, is that Point of the Firmament, which a right Line, drawn from the Centre of the Earth through the Centre of the Star, shall terminate in: And the visible and seeming place is likewise that point of the Firmament, which a right Line, drawn from the Eye of the beholder, (plac'd on the Earth's Surface,) through the Centre of the Star, shall then be terminated in. Wherefore because those two Points of the Firmament do fall into one and the same vertical Circle, a Parallax is wont to be defin'd to be the Arch of the Vertical Circle, that lies between the true and the seeming place of the Star. As for example, in Figure XVII. let A be the Centre of the Earth, C B D its Surface, B the Eye of the Beholder, E F G the Vertical in the Firmament. Now let the Star be first of all suppos'd to be in the visible Horizon in the Point H; and then a right Line A H I, drawn from A, the Centre of the Earth, through this Point H, does in the Firmament find the Point I, which is therefore the true place of the Star. Again, A right Line drawn from the Eye B, through the Star H, does in the Firmament find the seen or seeming place K; therefore the Parallax is I K. Afterwards the Star being ascended to L, the Parallax will be M N; if it come to O, the Parallax will be P Q; lastly, if it come to the Zenith R, there will be no Parallax at all: For then the Lines drawn from the Centre A, and the Eye B through the Star R, will Fig. XVII.

will fall both upon the same Vertical Point F. For whereas the Parallax is the greatest in the Horizon; as the Star ascends higher and higher, the Parallax is more and more lessen'd, till in the Zenith it come to be none at all. Besides, 'tis to be remembred, that the nearer a Star is to the Earth, so much the greater Parallax is has. For, for instance, a Star in S, that is in the same Line of Vision with H, has the Parallax T K, which is plainly greater than I K, the Parallax of the Star H. Likewise the very same Star, if it ascend to V, when it comes into the same Visual Line with L, it will have the Parallax N X, which is greater than M N the Parallax of the Star L. Lastly, A Star plac'd in Y, in the same Visual Line with O, has Q Z for its Parallax, which is still greater than is Q P, the Parallax of the Star O. Now the measure of the Arch of the Parallax, for instance of I K, is the Angle I H K, or the Angle that is oppos'd to it *Ad Verticum* A H B, which the Lines of the true and seeming place of the Planet do make in H, the Centre of it, and to which the Semidiametre of the Earth is the side of the Triangle, which is Subtended to the Angle aforesaid. For here the Angle A H B, is the difference of the two Angles F B H and F A H, of which the former gives the seeming distance of the Star from the Zenith, and the latter gives the true. But now besides these Parallaxes of Altitude, which are taken in the Vertical Circle, there are also two other kinds of Parallax, to wit, of Longitude and Latitude; the first of which is that Arch of the Ecliptick, which lies between two Circles of Latitude, that pass thorow the true and seeming place of the Star, the second is the Arch of any Circle of Latitude that lies between two Circles, parallel to the Ecliptick, that do likewise go through the seeming and true place of the Star. The chief use of these is in the Eclipses of the Sun. Now this is common to all sorts of Parallaxes, that by them the seeming place of the Star is always lower towards the Horizon, than the true place is: For 'tis a known Observation in opticks, that by how much the Eye is more elevated from the Centre of the Earth towards the Surface, the thing seen will appear so much the lower.

CHAP. IX.

Of Refractions.

HE that desires in some measure at least to understand the Nature of Refractions, let him put a Counter, or the like, in the bottom of a Bason, and then fix his Head in such a posture, that the edge of the Bason may hinder him from seeing the Counter. Then let him bid some body fill it up with water to the brim; and he shall find by Experience, that the Counter, which before could not be seen, will then appear to the Eye, though neither the Counter nor the Eye be mov'd out of their first places: Which is, because the Ray that comes from the Counter, which before light upon the Forehead, is so refracted by passing out of the water into the Air, that it falls upon the Eye, and makes the Counter visible. From this Experiment two things may be gather'd; the first is, That the Passage of the Ray through a twofold Medium, for example, out of Water into Air, or on the contrary, does make a Refraction; the other is, That the Rays that go out of a thicker Medium, as particularly Water, into a thinner, such as the Air is, being refracted, they decline from the perpendicular that falls upon the Surface which bounds both the Mediums: And again, the other way, when they come out of a thinner Medium into a thicker, they incline towards the said perpendicular. Therefore if we conceive the Atmosphere of the Earth, or the Vapours that surround the Earth, to be as they really are, a Body of a Globous Figure, whose Centre is the same with the Centre of the Earth, and suppose the Sun to be in the Horizon; 'tis clear, that the Rays will fall very obliquely, or very much aslope, upon that part of the Atmosphere, that hangs over our Heads; for they will fall upon it in the same manner, that they fall upon the Surface of the Earth, that is under our Feet. And when the Rays of the Sun, out the more pure and thin *Æther*, do enter into

into the Vaporous Air, that inclines something to the Nature of Water; then they will be very much refracted towards the perpendicular, that falls from our Zenith; whence it must needs be, that the Ray that is so refracted to our Eyes, must shew the Sun to be higher than it would be seen to be, if there was no Atmosphere.

Now, though the Quantity of the Horizontal Refraction be by *Tycho Brahe* defin'd to be some little greater in the Sun and Moon, than in the Stars; yet the same thickness of the Air seems to affect, after the same manner, the Rays that come from the same side of the Heavens, let them have pass'd never so great space of *Æther* before they reach the Atmosphere. And, as for that difference, which *Ticho* thought there is betwixt the Refractions of the Sun and of the Stars, it arose from the Parallax of the Sun, which by Him was determin'd to be of three Minutes, which yet scarce makes up the fourth part of a Minute. For by how much the more he suppos'd the Sun to be lower than it is, by giving to it a greater Parallax than it has, he was forc'd by Refractions to advance it so much the higher above the Stars that have no Parallax. Hence it is, that he makes the Horizontal Refraction of the Sun and Moon to be thirty three or thirty four Minutes, whereas He attributes to the Stars no greater than of thirty. But it seems more true, that an Horizontal Refraction of about thirty Minutes belongs to the Sun and Moon, and all the Stars; though indeed Experience plainly Testifies, That Refractions, even in the same Horizon, are greater or less, according to the Thickness or Thinness of the Vapours; and towards the Northern side of the World do generally increase, because the Air is thicker. Whence it came to pass, That the *Hollanders* Wintering in *Nova Zembla*, after a continual Night of some Weeks, the Sun appear'd to them above the Horizon, sooner than they expected, according to the Elevation of the Pole which they had taken. And for the same reason it is, That the Sun being in the Horizon, and being seen by a refracted Ray, seeming to be 30, that is, its whole Diametre, higher than really it is, when it seems to touch the Horizon with the lower Edge of it; it is at that time wholly beneath it.

Moreover, because of the continual Diminution of Refractions it is, that the lower Edge of the Sun being a little more refracted than the upper, it seems to be drawn nearer together to it; whence it comes, That the Sun at its Rising or Setting does not appear exactly round, but Ecliptical or Oval, having its perpendicular Diametre more contracted than the Cross-Diametre is. But though the Moon be as much elevated by Refraction as the Sun itself is; yet it is so, that when it touches the Rational Horizon with its lower Edge, it is as then wholly beneath the Visible: For indeed, if it was not as far from the Earth as the Sun, it would not only All appear, but by the help of Refractions it would leave the Horizon with all its Diametre: But the Parallax of the Moon, which is so near, depressing the same upper Edge again a whole Degree, it makes it all be hidden under the Horizon.

CHAP. X.

Of the Theory of the three higher Planets, Saturn, Jupiter, *and* Mars.

IT has been said above, That the Motion of Longitude of the three higher, as well as of the Moon, is affected with a double Inequality; the one sort of which is absolute, the other is tied to certain Approachments to the Sun. There is Difference between the Moon and the lesser Planets, that the first Inequality of the Moon depends upon the Revolution of the Epicycle, the second upon the Motion of the Eccentrick that carries the Centre of the Epicycle; but the first Inequality of the Planets depends upon the Eccentrick, and the second is owing to the Epicycle. And besides, the Epicycles of the lesser Planets

Planets move a contrary way, to that of the Moon's Epicycle: For they about the Apogée of the Epicycle, do go towards the Consequent Signs; but about the Perigée of the same towards the Antecedent. Now the Theories of these three upper Planets, do agree in having the like Circles and Lines; and are content with the same Laws, only they differ in the quantity of their Circles and Motions.

Fig. XVIII. 2. In Figure XVIII. let T be the Earth, C the Centre of the Eccentrick A D E, B the Centre of the Equant, as far distant from C, as this is from T; let A be the Apogée of the Eccentrick, P the Perigée, A B C T P the Line of the *Apses*, T E the Line of the middle Motion of the Planet, to which is always Parallel the Line B D, drawn from the Centre of the Equant, to the Centre of the Epicycle, which being continued to M, shews the middle Apogée of the Epicycle, as the Right Line T D V, drawn from T through the Centre of the Epicycle D, shews in V the true Apogée of the Epicycle; but the Line C D Q, being drawn from C, the Centre of the Eccentrick, through the same D, finds in Q the Point of Contact. Let the Planet be in F, and then T F will be the Line of the true Motion of the Planet.

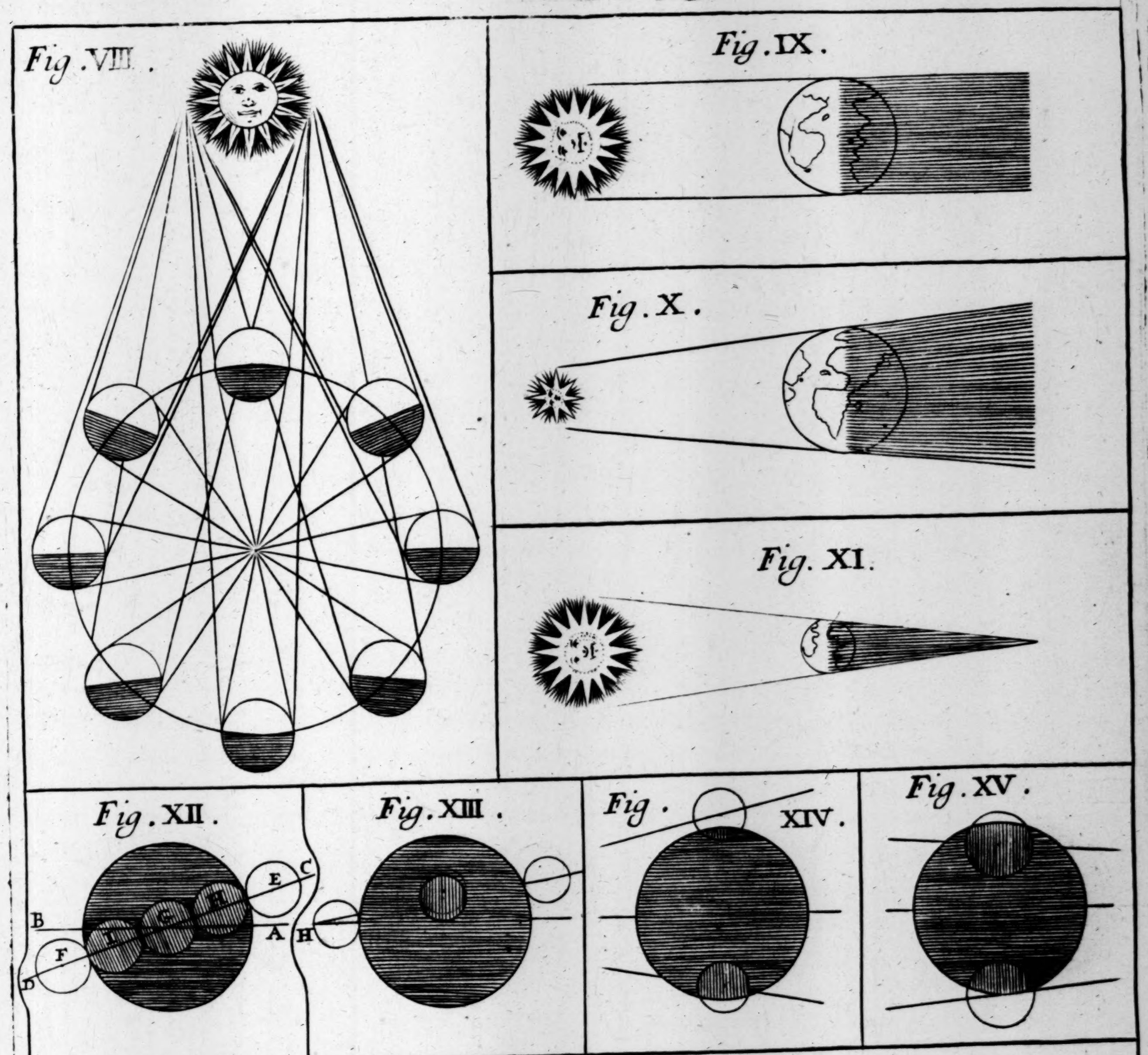
3. Now here a threefold Motion is to be consider'd: The first of the Line of the Apogée A B C T P, which being affix'd to the Point T, with the rest of its Length, is, according to *Ptolomy's* opinion, mov'd with the same Motion that the Sphere of the fix'd Stars has. The second is of the Eccentrick, that carries about the Centre of the Epicycle, from A through D to P, by an orderly Motion, not about its own Centre C, as in the Sun, nor about the Centre of the world T, as in the Moon, but about the Centre of the Equant B; namely, so that A B D in equal spaces of time is equally increas'd; as is also the Angle A T E between the Lines of the *Apses* A T, and of the middle Motion T E. Thirdly, The Motion of the Epicycle carries the Body of the Planet equally from M, the middle Apogée of the Epicycle towards F and G.

4. Now these Motions perform'd their Revolution thus: That of the Apogée in all the lesser Planets once in 36000 years, according to *Ptolomy*, to wit, in the space of time that the Firmament it self moves once round; but the Eccentrick of *Saturn* moves every day two Minutes, that of *Jupiter* five, of *Mars* 31 $\frac{1}{3}$; and so *Saturn* goes his Round once in 29 *Egyptian* years, *Jupiter* once in 11 *Egyptian* years and 316 days, *Mars* in one year and near upon 322 days. Lastly, These Planets are carried about in the Circumference of their Epicycles, the first of them in one year and thirteen days and $\frac{1}{4}$, the second in one year and almost 34 days; the third in two years and almost 60 days.

5. Now the Angle A B D, the space of which the Line of the middle Motion B D, (or T E) has receded from the Line of the *Apses* A B T, is call'd here as in the Moon, the middle Centre of the Epicycle; but the Angle A T D, is call'd the true or equaliz'd Centre of the Epicycle; and therefore the Angle B D T, which the middle Centre differs from the true, is call'd the Equation of the Centre. And M F the distance of the Planet from the middle Apogée of the Epicycle, is nam'd the middle Argument; as V M F the distance from the true Apogée, is call'd the true. Now the Angle D T F, is the Equation of the Orb or Revolution; and is sometimes greater, sometimes less in the same distance of the Planet F from the Perigée G, according as the Centre of the Epicycle D is farther or nearer to the Earth T. And therefore here again, there is also the same Diversity of the Diametre, that there was before in the Moon; and the same proportional Scruples too, and the same sort of Excess, though of a different quantity in each of the Planets.

6. Now first of all, That the Concurrence or Agreement of the Superiour Planets with the Sun, to Followers of the old Astronomy, seem'd to be very wonderful; *viz.* That the Revolution of every one of them in their own Epicycles, should be compleated just in so much time, as there is from one middle Conjunction or opposition with the Sun to another; so that in every middle Conjunction, the Planet is in the middle Apogée of the Epicycle, and in every opposition it is in the Perigée; and so the Planet is always as far distant from the middle Apogée of the Epicycle, as the Line of the middle place of the Sun, has departed from the Line of the Motion of the Planet, and consequently by Subtracting the middle Motion of the Planet from the middle Motion of the

Sun,



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Sun, the middle Argument of the Planet is found remaining. Whence it appears, that by how much the more slowly the Centre of the Epicycle goes forward in the Eccentrick, as particularly in *Saturn*; so much the sooner does the Sun return around to it again, and likewise the Planet goes the sooner round in the Circumference of the Epicycle, and on the contrary.

7. The Motion of the Superiour Planets in Latitude has also a twofold variety, (according to *Ptolomy*'s opinion at least:) For besides that the Orbit of the Planet inclines towards the Ecliptick, the Plain also of the Epicycle declines so from the Orbit, that it is parallel or almost parallel to the Plain of the Ecliptick. In Figure XIX. let the Line *a* T *b* represent the Ecliptick; (for it is well known, that a Circle may be so turn'd to the Eye, that it may appear to nothing else but a right Line;) and let *l* T *m* be the Orbit of the Planet, or the Eccentrick, cutting the Ecliptick in T. Now I say the Plain of the Epicycle *f l e*, or *g m h*, is not continued on with the Plain of the Eccentrick *c* T *d*, but declines from it the Angle *c l e*, which is almost equal to the Angle *c* T *a*, the space of which the Orbit inclines to the Ecliptick; so that *f l e* the Epicycle, and *a* T *b* the Ecliptick, are as it were parallel one to another. And hence it comes to pass, that the Latitude of the Planet does not only run out from the Ecliptick in the Periodical Motion of the Eccentrick, sometimes Northward, and sometimes Southward; but in every Revolution of the Epicycle, the same is increas'd by the Planet's coming to the Perigée of the Epicycle *f* or *g*, and is diminish'd by the Planet's being about the Apogée of the Epicycle *e* or *h*. For if the Epicycle *c l i* was instead of *f l e*, and so should fall upon the same Plain with the Orbit *c l i* T; the Planet, being in the Apogée of the Epicycle *c*, would then be farther distant from the Ecliptick *a* T, than it is now found to be in *e*, the Apogee of the Inclined Epicycle: And, on the other side, *f* the Perigée of the Inclined Epicycle, is farther distant from the Ecliptick *a* T, than *i* the Perigée of the Epicycle, when it falls upon the same Plain with the Orbit *c l i* T. Now the greatest Latitude of *Saturn* can scarce come to two Degrees, and five or six Minutes; nor of *Jupiter* to above one degree, and also five or six Minutes; nor of *Mars* to above seven degrees in all. Fig. XIX.

CHAP. XI.

Of the Theory of Venus.

1. THE Motion of *Venus* in Longitude, according to *Ptolomy*, has the same Circles and Lines belonging to it, that the superiour Planets have, and is explain'd with the same terms: And moreover the Motions of the Eccentrick, and of the Epicycle do tend the same way, though the Motion of the Eccentrick is not in every place govern'd by the same Law; for that Line of the middle Motion, which in the superiour Planets was absolute, or not tied to any other, is here so tied to the Line of the middle Motion of the Sun, that it is the very same; I say the Line T E, of the Figure XVIII. does in *Venus* always agree with the Line of the middle Motion of the Sun, to which is always parallel the Line B D, (which therefore may be also call'd the Line of middle Motion,) drawn from the Centre of the Æquant B, through the Centre of the Epicycle D. Fig. XVIII.

2. Now though the Inequality, which happens to *Venus*, by reason of the Motion of the Eccentrick, that agrees with the Motion of the Sun, may seem to be tied, (as well as the other which is deriv'd from the Epicycle;) yet in a true and sound sense, it is to be reckon'd absolute; namely, because the Motion neither of the Sun, nor of the Eccentrick of *Venus*, is tied to the coming together of *Venus* and the Sun; but she may be in Conjunction with him, in what place soever of the Eccentrick the Centre of the Epicycle is found.

3. But now from this continual Connexion of the Lines of the middle Motion of the Sun, and of *Venus*, there follows another certain thing, through which it is, that her *Phænomena* are very much different from those of the

Superior

Superior Planets; namely, That *Venus* can never go farther from the Sun, than her Epicycle will suffer her: And for this reason she is the Sun's constant Companion, scarce going from him at any time above half a Sign. And whereas the Superior Planets, in the Perigée of their Epicycles, are in Opposition to the Sun, and the Apogée in Conjunction with Him; She both in the Apogée and Perigée is in Conjunction with the Sun.

4. Although, by reason of the Epicycles of all the lesser Planets tending the same way, it happens, that they are all Retrograde in the Perigée of the Epicycle, because it is contrary to the Motion of its Centre, and move the fastest when in the Apogée of the Epicycle, because 'tis carried the same way with its Centre, and therefore quickens the Motion of the Planet; yet they are Stationary, when they are a little below* the Contingent Line drawn from the Earth to the Circumference of the Epicycle, where the Planet goes as far back in the Circumference of the Epicycle, as it is mov'd forward by the Centre of the same.

5 Now *Venus* moves from the Apogée of the Epicycle round to it again, in almost nineteen Months; so she is about nine Months and an half in going from Apogee to Perigee, and is all that time the Morning Star: but the other nine Months and an half, while she is ascending from the Perigée to the Apogée of the Epicycle, she rises as the Morning Star before the Sun.

CHAP. XII.

Of the Theory of Mercury.

1. THIS Planet in all things agrees with *Venus*, excepting the Motion of the Eccentrick, and the different Quantity of Lines and Motions. Now as for the Motion of the Eccentrick, in Figure XX, let T be suppos'd to be the Earth, B the Centre of the Equant; 1, 2, 3, 4, 5, 6, the Equant it self; C the Centre of the little Circle, in whose Circumference goes about the Centre of the Eccentrick, according to the order of the Points, *g*, *h*, *i*, B, *k*, *l*. The Circles made with Points represent the Eccentrick in its various Positions; and I have made G and *g*, as also H and *h*, and so on, that is, the great and little Letters of the same kind, to signifie for instance, that G is the Circumference of the Eccentrick, when its Centre is in *g*, and H when it is in *h*, and so on: Whence it follows, That it happens only once in every Revolution of the Eccentrick, (which is yearly, being equal to the middle Motion of the Sun,) that the Centre of the Eccentrick is joyn'd in B to the Centre of the Equant, and so that the Eccentrick is the same with the Equant 1, 2, 3, 4, 5, 6, but at all other times they are different. Now T B is equal to B C, and T B C drawn out on each side is the Line of the middle Apogée, which goes forward with the same Motion that the Firmament has, and is the same with the Line of the true Apogée, when the Eccentrick and the Equant are coincident, otherwise it differs from it: For when, for Example, the Centre of the Eccentrick is in *h*, then T B C *g* does indeed remain the Line of the middle Apogée, but the Line of the true Apogée is to be drawn from the Earth T, through *h* the Centre of the Eccentrick.

Fig. XX.

2. Now therefore the Motion of the Eccentrick is compounded of two Motions, *viz.* Of the Centre of the Eccentrick, which is carried about in the little Circle *g h i* B *k l* with a Motion equal to the middle Motion of the Sun; and then of the Line of the middle Motion of *Mercury*, passing through the Centre of the Equant B, and which is always parallel to the Line of the middle Motion of the Sun: So that these two Motions agree in the Quantity of the time of their Revolution, but do tend two contrary ways; the first from *g* through *h* and *i*, but the second from being in the Situation of B 1, to the Situation of B 2, B 3, &c. for in the place where the Lines B 1, B 2, &c do cut the Eccentrick, thither you shall find the Centre of the Epicycle carried by Motion of the Eccentrick. Let the Centre of the Eccentrick be in *g*, then

the Line of the middle Motion of *Mercury* will be B 1, and the Centre of the Epicycle in G. Again, Let the Centre of the Eccentrick be in *h i* B *k l*, the Line of the middle Motion of *Mercury* will be B 2, B 3, B 4, B 5, B 6, and the Centre of the Epicycle in H I *b* K L.

3. And now hence 'tis evident, That the Centre of the Epicycle being carried about by such a compound Motion of the Eccentrick as this, does, in moving about the Earth T, make an Oval Figure G H I *b* K L. And farther, by reason of the same Motion it happens, that the Centre of the Epicycle is twice in every Revolution in its Perigée in the Points I and K, (which are nearer the Earth T, than is the Point *b*,) but is only once the farthest from the Earth in the Point G.

4. And so the Motion of the Centre of the Epicycle, which agrees with that compounded of the Motion of the Eccentrick, being thus conceiv'd, it will be afterwards easie to take a view of those other things, that farther happen to the Epicycle: For in Figure XXI, the Line drawn from the Centre of the Equant B, through the Centre of the Epicycle, shews the middle Apogée of the Epicycle in the Point M; but one drawn from the Earth T, through the Centre of the Epicycle, (being the Line T V,) it shews in V the true Apogée of the Epicycle. Lastly, The Line *g* G Q, or *h* H Q, or *i* I Q, being drawn from the Centre of the Eccentrick *g h i*, &c. through the same Centre of the Epicycle, it finds in Q the Point of Contact: And so *Mercury* is moved in the Circumference of the Epicycle, always by equal Motions, departing farther and farther from M, his middle Apogée, till he return to the same again, after the space of one hundred and fifty days: Whence it follows moreover, that he is in Conjunction with the Sun in the Apogée of the Epicycle, as well as in the Perigée, as was said before of *Venus*; Namely, because his as well as her Line of middle Motion T E is always joyn'd with the Line of the middle Motion of the Sun, and to it is continually parallel the Line B M, which may also be called the Line of the middle Motion. It also follows, that *Mercury* departs no farther from the Sun, than his Epicycle will suffer him; which since, in proportion to its Eccentrick, it is less than the Epicycle of *Venus*, it thence comes to pass, that his Departure from the Sun is the less, *viz.* scarce at any time a whole Sign. But his greatest Digression in the Epicycle, when his Centre, is nearest the Earth in I and K, appears to be near upon 23^{d}, 52$'$; which yet, when the Centre of the Epicycle is in the Apogée of the Eccentrick G, does but come to little more than 19^{d}; which is to be imputed to the Diversity of the Diametre of the Epicycle, which is seen sometimes under the Appearance of a greater Angle, and sometimes of a less. Now *Mercury* appears in the Evening, while it is carried from the Apogée of the Epicycle V, through F, to the Perigée G; and in the Morning, while it is again ascending from G to V: And if there be any other things, that follow the Motion of the Epicycle just now explain'd, those, I say, may be understood from the Theory of *Venus*. It remains now, that I say something of the Latitude of both. Figure XXI.

In Figure XXII, Let the Circle *a b c d e* represent the Plane of the Eccentrick of *Venus* and *Mercury*, and let the Face of the Plain, that you see with your Eyes, be suppos'd to be turn'd towards the Northern Pole of the Ecliptick: And let *b a d* be the Line of the *Apses*, *b* the Apogée, *d* the Perigée; and let the Right Line *c a e* be drawn through the Centre of the World *a*; so as to cut the Line of the *Apses* at right Angles, and also to represent the Ecliptick, and the Plain of the Eccentrick, mutually cutting one another: And so the Ascending Node is *e*, and the Descending *c*. Now the Plane of the Eccentrick comes to the Plane of the Ecliptick, and again goes from it by a sort of wavering Motion, that perfects its Revolution in the same space of time, in which the Centre of the Epicycle goes about through *e b c d e*. For the Centre of the Epicycle being in *e*, both the Planes, (*i. e.*) of the Eccentrick and the Ecliptick, are united; but the Centre of the Epicycle proceeding from *e* to the Apogée *b*, the Plane of the Eccentrick does deviate from that of the Ecliptick, departing in the upper part of it *e b c*, in *Venus* indeed towards the North, but in *Mercury* towards the South; but at the same time] the lower part *c d e* does leave the Ecliptick the contrary way, (*i. e.*) in *Venus* Northward, Figure XXII.

 and

and in *Mercury* Southward. And so the Centre of the Epicycle proceeding from *b* to *c*, the Plane of the Eccentrick does again come to the Ecliptick by little and little, till it be united in the descending Node *c*. And again, the Epicycle proceeding from *c* to *d*, the lower part of the Plane of the Eccentrick *c d e*, departs from the Ecliptick, in *Venus* Northward, but in *Mercury* Southward, but in the mean time, the upper part *e b c*, declines from the Ecliptick the other way *(i. e.)* in *Venus* Southward, but in *Mercury* Northward. And by and by the Epicycle proceeding from *c* to *d*, the Plane of the Eccentrick comes again to the Ecliptick by little and little, till it be again united to it in the Ascending Node. Hence it may be understood, that the Centre of the Epicycle of *Venus*, has always its distance from the Ecliptick Northward, unless when in the Points *e* and *c*, it falls upon the Plane of the Ecliptick, and so that part of the Plane of the Eccentrick, which the Centre of the Epicycle of *Venus* does pass over, (whether that be the upper part, as *e b c*, or the lower, as *c d e*,) does always deviate from the Ecliptick towards the North; but we are to understand the quite contrary of *Mercury*. And now this Libration of the Eccentrick they commonly call the Deviation; but besides this, there is also an Inclination of the Epicycle to the Plane of the Eccentrick, which gives a Latitude to *Venus* and *Mercury*: For in the same Figure XXII. let *f g*, or *h i*, or *k l*, be taken for the Line of the mutual Section of the Epicycle and Eccentrick, which, while the Centre of the Epicycle is mov'd through *b c d e*, *d* is always situated parallel to the Line of the *Apses b a d*: Also let the left part of the Epicycle *f m g*, *h o i*, or *k q l* be understood perpetually to decline from the Plane of the Eccentrick, in *Venus* to the North, in *Mercury* to the South; but let the right side of the Epicycle *f n g*, or *h p i*, or *k r l* be understood perpetually to tend quite the other way, in *Venus* to the South, in *Mercury* to the North

CHAP. XIII.

Of the true System of the World.

1. THough *Ptolemy's Hypothesis*, which I have been hitherto explaining, do salve most of the *Phænomena* of the Stars, that could be observ'd by the bare Eye, if so be the quantities of Lines and Motions be limited by those Observations he had got of many Times; yet certain it is, that not only the same may be all accounted for, by an easier and far more probable *Hypothesis*, but that also there are certain *Phænomena*, found by new-invented Tubes or Telescopes, which can in no wise consist with his System of the World: For he places the Earth in the Centre, and then supposes, that the Orbs of the Planets do surround in this order, first the Moon, then *Mercury*, *Venus*, the Sun, *Mars*, *Jupiter*, *Saturn*, and, last of all, the Sphere of the fix'd Stars; as Figure XXIII. does present them to our view. But now our Telescopes do shew us those *Phases* of *Venus* and *Mercury*, that do manifestly prove, that those two Planets are distant from us sometimes beyond the Sun, and sometimes on this side: For, sometimes they are horned, other times half full, then gibbous, and last of all in the full, no otherwise than the Moon is. Whence 'tis thus argued, if they were always under the Sun, (as *Ptolemy* thought,) they would either appear halfed, or like a Sickle, or not at all, seeing they would either hold towards us their whole enlighten'd Hemisphere that is turn'd to the Sun, or else the greatest part of it would be turn'd away from us; but if they were continually above the Sun, they would always appear Full, or as if they were so, for the contrary reason: Therefore since they appear sometimes like half Moons, and sometimes in the Full, they must be sometimes beneath, and sometimes above the Sun; therefore I say, their Orbits do encompass the Sun: But they cannot surround the Earth, because they never go far from the Sun, nor ever come into Opposition with him; which yet they must necessarily do, if the said Orbits did include not only the Sun, but the Earth too. And farther, Figure XXIII. the Orbit of *Mercury* is included within the Orb of *Venus*, because his greatest Digression from the Sun is less than that of *Venus*; and also because he being nearer the Sun,

Figure XXIII.

is

f a more lively brightness, than either *Venus* or any other Planet. On the con-ry, *Mars*, *Jupiter*, and *Saturn*, unless they mov'd about the Earth, they could come into Opposition with the Sun: But they also go about the Sun too; if they went under it, at the time of Conjunction they would appear hor-d, as the Moon does. 'Tis plain also, that the Earth, though it be included the Orbits of the Superiour Planets, *Mars*, *Jupiter*, and *Saturn*; yet it is not aced in the Centre of them: For *Mars* is five times nearer the Earth when in pposition, than he is when in Conjunction; and so appears five times greater ere, than he does here: For the apparent Diametre of a Planet, observ'd by e Telescope, is lessen'd in proportion to the Increase of its distance from the arth. Now the Diametre of *Jupiter* is increased only the half from its Con-nction to its Opposition; whence 'tis therefore likewise inferr'd, that the Earth plac'd beyond the Centre of the Orbit of *Jupiter*, but not in the same pro-ortion to the whole Circumference that it is distant from the Centre of the rbit of *Mars*: And besides the *Phænomena* seem to intimate, that the Sun is not r from the Centre of the Orbit of every primary Planet; so that they have e common Centre of their Orbits (namely the Sun) at an equal distance from e Earth: And moreover 'tis manifest, that that Planet, to whose Orbit that mmon distance of the Centre has the least proportion, that has the greater rcuit about the Sun, and so the Orbit of *Jupiter* encompasseth that of *Mars*, d for the same reason it self is contain'd within the Orbit of *Saturn*. Lastly, hat the Moon moves about the Earth is evident from hence, *viz.* because it ay not only be in Conjunction with the Sun, but also in Opposition with it: d that it is the nearest of all to us, is plain; because no Planet has so great Parallax, as it has; wherefore it must needs be the nearest to the Earth.

2. Now therefore from these *Phænomena* now mention'd, it will be no diffi-'t thing to frame a true System of the world: For in Figure XXIV. let us pose the Earth to be in *x*, and let the little Circle that encompasses it next ll, be suppos'd to be the Orbit of the Moon. Then from thence let a space taken from the Earth *x*, even to *a*, beyond the Orbit of the Moon; and *x a* be the nearest distance of *Venus* from the Earth; and then from *a* to *b*, *a b* be five times as much as *x a*, so that *x b* the greatest distance of *Venus* m the Earth, may bear the same proportion to *x a* the least distance, that as to 1. Let *a b* be divided into two parts, and let *c* be the Sun it self; so t *Venus*, with respect to the Earth *x*, may sometimes be as well on this side e Sun in *a*, as beyond it in *b*. And now within the Orbit of *Venus a b*, let e Orbit of *Mercury d* be drawn; and then let the Orbit of *Mars e f*, encom-pass both the Earth *x* and the Sun *c*, so that *x e*, the nearest distance of *Mars* from the Earth, may be a little greater than *x a*, the least distance of *Venus*; since the Parallaxes of both these Planets, when they are nearest to the Earth are almost the same, only that of *Mars* is something the less. Then the Circle *f*, made with the Semidiametre *c e*, will be the true Orbit of *Mars* for a twofold Reason; first, because by these means the Sun *c* will be in the Centre of the Orbit of *Mars*, or very near it, as the *Phænomena* hereafter to be spoken of do require: And then secondly, because so the greatest distance of *Mars x f*, has a fivefold proportion to the least distance *x e*, or is five times greater, as the proportion of the greatest apparent Diametre to the least does require. Lastly, Let the Orbit of *Jupiter g h*, be drawn round them all, whose Semidia-metre *c g* let be almost five times greater than the Semidiatre either of the Orbit of the Earth, or of the Sun *c x*; and let *i k* be the Orbit of *Saturn*, whose Semidiametre *c i*, let be almost ten times as big as the Semidiametre *c x*, the *Phænomena* hereafter to be explain'd requiring both to be so: And thus shall we have the true System of the World composed, as the black Circles do set it out. And if the fix'd Stars did not appear in the Heavens, that shew that the Sun does every year walk through the twelve Signs of the Zodiack; and if the Planets, besides their first Inequality, had not also a yearly one; and lastly, if we had not the Vicissitudes of Summer and Winter, as also the lengthening and shortening of Days and Nights; there would be no need of Pointed Circles, the one of which, *c m*, does shew the Orbit of the Sun moving about the Earth, the other, *x l*, the Orbit of the Earth, moving about the Sun: For the Appearances of the first Inequality in the Planets might be as well explain'd, if neither the

Figure XXIV.

 Sun

and in *Mercury* Southward. And so the Centre of the Epicycle proceeding fr *b* to *c*, the Plane of the Eccentrick does again come to the Ecliptick by li and little, till it be united in the descending Node *c*. And again, the Epic proceeding from *c* to *d*, the lower part of the Plane of the Eccentrick *c d e*, parts from the Ecliptick, in *Venus* Northward, but in *Mercury* Southward, in the mean time, the upper part *e b c*, declines from the Ecliptick the oth way (*i. e.*) in *Venus* Southward, but in *Mercury* Northward. And by and by the Ep cycle proceeding from *c* to *d*, the Plane of the Eccentrick comes again to th Ecliptick by little and little, till it be again united to it in the Ascending Nod Hence it may be understood, that the Centre of the Epicycle of *Venus*, has a ways its distance from the Ecliptick Northward, unless when in the Point *e* and *c*, it falls upon the Plane of the Ecliptick, and so that part of the Plan of the Eccentrick, which the Centre of the Epicycle of *Venus* does pass over, (whe ther that be the upper part, as *e b c*, or the lower, as *c d e*,) does always devi ate from the Ecliptick towards the North; but we are to understand the quit contrary of *Mercury*. And now this Libration of the Eccentrick they common ly call the Deviation; but besides this, there is also an Inclination of the Ep cycle to the Plane of the Eccentrick, which gives a Latitude to *Venus* and *Me cury*: For in the same Figure XXII. let *f g*, or *h i*, or *k l*, be taken for t Line of the mutual Section of the Epicycle and Eccentrick, which, while t Centre of the Epicycle is mov'd through *b c d e*, *d* is always situated parallel the Line of the *Apses b a d*: Also let the left part of the Epicycle *f m g*, *h o* or *k q l* be understood perpetually to decline from the Plane of the Eccentric in *Venus* to the North, in *Mercury* to the South; but let the right side of th Epicycle *f n g*, or *h p i*, or *k r l* be understood perpetually to tend quite the oth way, in *Venus* to the South, in *Mercury* to the North

CHAP. XIII.

Of the true System of the World.

1. Though *Ptolemy's Hypothesis*, which I have been hitherto explaining, do sa most of the *Phænomena* of the Stars, that could be observ'd by the b Eye, if so be the quantities of Lines and Motions be limited by those Obser tions he had got of many Times; yet certain it is, that not only the sam may be all accounted for, by an easier and far more probable *Hypothesis*, b that also there are certain *Phænomena*, found by new-invented Tubes or Tel scopes, which can in no wise consist with his System of the World: For he plac the Earth in the Centre, and then supposes, that the Orbs of the Planets do sur round in this order, first the Moon, then *Mercury*, *Venus*, the Sun, *Mars*, *Jupi ter*, *Saturn*, and, last of all, the Sphere of the fix'd Stars; as Figure XXIII. doe present them to our view. But now our Telescopes do shew us those *Phases* of *Venus* and *Mercury*, that do manifestly prove, that those two Planets are distan from us sometimes beyond the Sun, and sometimes on this side: For, sometimes they are horned, other times half full, then gibbous, and last of all in the full, no otherwise than the Moon is. Whence 'tis thus argued, if they were always under the Sun, (as *Ptolemy* thought,) they would either appear halfed, or like a Sickle, or not at all, seeing they would either hold towards us their whole enlighten'd Hemi sphere that is turn'd to the Sun, or else the greatest part of it would be turn'd away from us; but if they were continually above the Sun, they would always appear Full, or as if they were so, for the contrary reason: Therefore since they appear sometimes like half Moons, and sometimes in the Full, they must be sometimes be neath, and sometimes above the Sun; therefore I say, their Orbits do encompass the Sun: But they cannot surround the Earth, because they never go far from the Sun, nor ever come into Opposition with him; which yet they must necessarily do, if the said Orbits did include not only the Sun, but the Earth too. And farther, Figure XXIII. the Orbit of *Mercury* is included within the Orb of *Venus*, because his greatest Digres sion from the Sun is less than that of *Venus*; and also because he being nearer the Sun, is

Figure XXIII.

is of a more lively brightness, than either *Venus* or any other Planet. On the contrary, *Mars*, *Jupiter*, and *Saturn*, unless they mov'd about the Earth, they could not come into Opposition with the Sun: But they also go about the Sun too; for if they went under it, at the time of Conjunction they would appear horned, as the Moon does. 'Tis plain also, that the Earth, though it be included in the Orbits of the Superiour Planets, *Mars*, *Jupiter*, and *Saturn*; yet it is not placed in the Centre of them: For *Mars* is five times nearer the Earth when in Opposition, than he is when in Conjunction; and so appears five times greater there, than he does here: For the apparent Diametre of a Planet, observ'd by the Telescope, is lessen'd in proportion to the Increase of its distance from the Earth. Now the Diametre of *Jupiter* is increased only the half from its Conjunction to its Opposition; whence 'tis therefore likewise inferr'd, that the Earth is plac'd beyond the Centre of the Orbit of *Jupiter*, but not in the same proportion to the whole Circumference that it is distant from the Centre of the Orbit of *Mars*: And besides the *Phænomena* seem to intimate, that the Sun is not far from the Centre of the Orbit of every primary Planet; so that they have the common Centre of their Orbits (namely the Sun) at an equal distance from the Earth: And moreover 'tis manifest, that that Planet, to whose Orbit that common distance of the Centre has the least proportion, that has the greater Circuit about the Sun, and so the Orbit of *Jupiter* encompasseth that of *Mars*, and for the same reason it self is contain'd within the Orbit of *Saturn*. Lastly, That the Moon moves about the Earth is evident from hence, *viz.* because it may not only be in Conjunction with the Sun, but also in Opposition with it: And that it is the nearest of all to us, is plain; because no Planet has so great a Parallax, as it has; wherefore it must needs be the nearest to the Earth.

2. Now therefore from these *Phænomena* now mention'd, it will be no difficult thing to frame a true System of the world: For in Figure XXIV. let us suppose the Earth to be in *x*, and let the little Circle that encompasses it next of all, be suppos'd to be the Orbit of the Moon. Then from thence let a space be taken from the Earth *x*, even to *a*, beyond the Orbit of the Moon; and let *x a* be the nearest distance of *Venus* from the Earth; and then from *a* to *b*, let *a b* be five times as much as *x a*, so that *x b* the greatest distance of *Venus* from the Earth, may bear the same proportion to *x a* the least distance, that 6 has to 1. Let *a b* be divided into two parts, and let *c* be the Sun it self; so that *Venus*, with respect to the Earth *x*, may sometimes be as well on this side the Sun in *a*, as beyond it in *b*. And now within the Orbit of *Venus a b*, let the Orbit of *Mercury d* be drawn; and then let the Orbit of *Mars e f*, encompass both the Earth *x* and the Sun *c*, so that *x e*, the nearest distance of *Mars* from the Earth, may be a little greater than *x a*, the least distance of *Venus*; since the Parallaxes of both these Planets, when they are nearest to the Earth are almost the same, only that of *Mars* is something the less. Then the Circle *e f*, made with the Semidiametre *c e*, will be the true Orbit of *Mars* for a twofold Reason; first, because by these means the Sun *c* will be in the Centre of the Orbit of *Mars*, or very near it, as the *Phænomena* hereafter to be spoken of do require: And then secondly, because so the greatest distance of *Mars x f*, has a fivefold proportion to the least distance *x e*, or is five times greater, as the proportion of the greatest apparent Diametre to the least does require. Lastly, Let the Orbit of *Jupiter g h*, be drawn round them all, whose Semidiametre *c g* let be almost five times greater than the Semidiatre either of the Orbit of the Earth, or of the Sun *c x*; and let *i k* be the Orbit of *Saturn*, whose Semidiametre *c i*, let be almost ten times as big as the Semidiametre *c x*, the *Phænomena* hereafter to be explain'd requiring both to be so: And thus shall we have the true System of the World composed, as the black Circles do set it out. And if the fix'd Stars did not appear in the Heavens, that shew that the Sun does every year walk through the twelve Signs of the Zodiack; and if the Planets, besides their first Inequality, had not also a yearly one; and lastly, if we had not the Vicissitudes of Summer and Winter, as also the lengthening and shortening of Days and Nights; there would be no need of Pointed Circles, the one of which, *c m*, does shew the Orbit of the Sun moving about the Earth, the other, *x l*, the Orbit of the Earth, moving about the Sun: For the Appearances of the first Inequality in the Planets might be as well explain'd, if neither the

Figure XXIV.

 Sun

Sun was carried about the Earth, nor the Earth about the Sun, by an Annual Motion; supposing the Centres of the Sun and of the Earth, do every year come a little nearer to one, and again remove to a farther distance. But so many other *Phænomena*, as were just now nam'd, do necessarily require, that either the Sun must be suppos'd to move yearly about the Earth, or else the Earth about the Sun; so that if the Sun be carried about, the Earth rests, or else 'tis the contrary way. If with *Tycho* we suppose the Sun to move, only the Earth stands still in *x*, and the Sun moving from *c*, through *n* and *m*, all the Orbits of the Planets do go along with it, (excepting the Moon;) so that the Centre *c* being transferr'd out of its place, they are transferr'd likewise, and by the same Motion all the Points of every Orbit do describe a Circle equal to the Circle of the Sun; as for instance, the Point *h* of the Orbit *h g*, does describe the Circle *h o p*, equal to the Circle *c n m*, which is described by the Centre *c*. But now, if, following *Copernicus*, we suppose the Earth to move; then all the Orbits remain in their places, as the Sun their Centre does also remain immovable in *c*; and only the Earth must be mov'd from *x*, through *q* to *l* in the same time, that the Sun should be mov'd from *c*, through *n* to *m*. And now the Arch of the Earth's Motion *x q*, being suppos'd to be equal to the Arch of the Motion of the Sun *c n*, to our Eye, that is plac'd in the Earth, the Sun will seem to move to the same part of the World, whether it be moved, or the Earth: For, first, the Sun being moved from *c* to *n*, and the Eye resting in *x*, the Ray from the Eye to the Sun is *x n*: And again, the Earth being moved from *x* to *q*, (whither also the Eye will come, while the Sun rests in *c*,) the Ray from the Eye to the Sun is *q c*. Now I say, this Ray *q c* is directed towards the same part of the World, towards which the Ray *x n* is also directed; and that the Ray *q c* is parallel to the Ray *x n*; which parallel Rays, if they reach a vast length, even to the Sphere of the fix'd Stars, they will consequently seem to fall in with one another into one and the same Line; for the vast length to which they are extended, does make their distance as it were vanish into nothing; and for this Reason the Sun seems to be in the same point of the Firmament, whether it be seen by the Ray *q c*, or by the other *x n*; and so there will be the same *Phænomena*, whether the Sun move about the Earth, or on the contrary: Neither is there any Reason for any one to except against so vast an Extension of the Firmament, for that it is really such, and so great one Argument is, that for instance, the *Sirius*, or Dog-star, which to the bare Eye seems to be almost as big as *Jupiter*, yet by the Telescope it appears to be but a mere Point; whereas *Jupiter* being by the same Instrument seen by one Eye, and compar'd with the Moon seen by the other Eye, being bare, does seem to have three times a greater Diametre than the Moon has: But if the Dog-star was no farther off than *Jupiter*, it would scarce seem to be less than *Jupiter* by the Telescope: Whence we may gather, that there is in a manner no proportion between the distance of *Jupiter* and the Dog-star. But besides, considering the so various and manifold Motions of all the Planets, *viz.* how they move directly, are sometimes Stationary, sometimes Retrograde; are also slower and swifter, do approach, and again recede from the Earth, and have an Increase and Decrease of their Apparent Latitudes and Magnitudes, (all which *Phænomena* may be accounted for barely by the yearly Motion of the Earth about the Sun,) who cannot but judge it very probable, that the Earth does move about the Sun indeed? Especially since the Orb of *Saturn* is almost ten times greater than the Orb of the Sun, than the Orb of *Jupiter* five times, and six times greater than that of *Mars*: Nor is it likely or credible, that the lesser Circles, such as is that of the Sun, should carry the greater Orbits of the superiour Planets, as *Tycho's Hypothesis* does require: To say nothing, that in this the Orbit of *Mars* cuts that of the Sun, and so at certain times the Body of *Mars* may come into that space of the Airy Region of the World, in which the Sun is at other times, which as to the primary Planets is very incredible; *viz.* that the Regions they pass through should be so confounded. Moreover for the Analogy or near resemblance there is between the Earth and the other Planets, as they are all opaque or gross Bodies, and the Earth does shine, as the rest do, by a reflected Light, as is plain from the brightness of reflecting Clouds, and from the Earth's illustrating the Moon with a dim Light; they are also all (as far as can be observ'd) of rough, uneven surfaces, and, like the Earth, are turn'd about their own Axles, and those inclining to the Ecliptick in their daily Motion, and

so have the same changes of night and day, Summer and Winter; nay, and farther are accompanied with Moons proper to them, *Jupiter* with four, and *Saturn* with three, which they Eclipse, and again are Eclipsed by them. For this Analogy, I say, the Earth seems to be of right to be reckon'd among the Planets; and the Sun, because he has not the same Analogy, seems to be plac'd in the only Centre of them all; especially seeing not only the Motions of every one of them would appear uniform enough, if they were look'd upon from the Sun; and seeing their distances from it are almost every where equable, which from the Earth appear to be very unequal; but also the Revolutions of the Stars about *Jupiter* with respect to the Sun, would be more regular, than they are seen to be from the Earth. And as their Revolutions have among themselves the proportion of half as much more as their distances are from the Centre of *Jupiter*, (that is, the Squares of the times, in which they finish their Revolutions, are as the Cubes of their distances from the Sun,) which is also true of the Companions of *Saturn*, so that this seems to be the general Rule of the Concentral celestial Motions; so likewise the Times of the primary Planets Revolutions, have the proportion to one another of half as much more as their indifferent distances are from the Sun, as *Kepler* observ'd; and therefore these ought to be accounted no other than Lunar Companions, that mov'd about the Sun.

And hence it is, that now most Astronomers receive *Copernicus*'s System of the World, as far more probable than any other, which accordingly I shall endeavour to illustrate in what follows, though in explaining the Motions of the Luminaries, *Tycho*'s Calculation be generally to be preferr'd before the rest. Wherefore I shall lay down, in the first place, *Tycho*'s Theory of the Luminaries as distinctly as I can, and shall retain it in computing the Motion of the Moon, and of the Eclipses of both Luminaries.

CHAP. XIV.

Of Tycho's *Theory of the Moon.*

1. BEcause *Tycho*'s Theory of the Sun does altogether agree with *Ptolomy*'s, differing only in the quantity of Motions and Lines; therefore I streightway enter upon his Theory of the Moon. And here first of all 'tis to be noted, that *Tycho* does explain the first Inequality of the Moon, and of the rest of the Planets, by a certain Circle that carries two Epicycles, *viz.* one bigger than another. As in Figure XXV. the Circle that carries the Epicycle is B C D E, in whose Circumference the Centre of the greater Epicycle is carried about from B towards C, D, and E; and again the greater Epicycle does carry about the less with it, whose Centre *n* it has fix'd in its Circumference. Figure XXV.

And now the quantity and proportion of these Circles is this: The Semidiametre of the Deferent, (or Circle that carries the Epicycles about,) namely, the Line A B, is equal to 56 ½ Semidiametres of the Earth. Now if in the said Semidiametre A B, there be suppos'd to be 100000 Parts; then of such parts 2174, are to be allow'd to the Semidiametre A H, and to the Semidiametre of the greater Epicycle B *n* or C *n* 5800; and lastly, to the Semidiametre of the lesser Epicycle 2900, which is half of the former.

2. Now these Lines are so mov'd, that the Line of the Apogée D A B, is first conceiv'd to be fix'd to the point A; but is movable in the rest of its length, so that in about nine years it passes through the Zodiack: Therefore from this Line of the Apogée, the Centre of the greater Epicycle being so many Months departed, it returns back to the same from B, through C D E, till it again overtake B, the Apogée of the Moon, a little beyond the Point of the Zodiack, in which it had last left it. Again, the right Line B *n*, C *n*, D *n*, E *n*, drawn from the Centre of the greater Epicycle to the Centre of the less, is always parallel to this Line of the Apogée D A B; whence it follows, that the Centre of the greater Epicycle being in C, the Angle *m* C *m*, or the Arch *m n*, the space of which the Centre of the lesser Epicycle is departed from the Apogée of the greater

greater *m*, is always equal to the Angle B A C, or to the Arch B C, the space of which, the Centre of the greater Epicycle is departed from the Line of the Apogée D A B; and they both are call'd the middle Anomaly of the Moon: But the Motion of the lesser Epicycle is always double to the Motion of the greater Epicycle, (as also the Ray of the greater C *n*, is double to the Ray of the lesser *n i*,) and it always begins from *a*, the point of its Circumference, which the Line that joins the Centres B *a n*, C *a n*, &c. do pass through: So the Centre of the greater Epicycle being in the Apogée B, the Motion of the greater Epicycle begins from *n*, and of the lesser, and so consequently of the Body of the Moon from *a*. Again, The Centre of the greater Epicycle being in C, if *m n* be the Quadrant of the Circle, the Semicircle will be *a e i*, and the Moon will be in *i*; also the Centre of the greater Epicycle being in D, if *m o n* be the Semicircle, the whole Circle will be *a e i o a*, and the Moon will return from *a* to *a*. Lastly, The Centre of the greater Epicycle being in E, so that the Arch B C D E consist, for instance, of ten Signs; then likewise the Motion of the greater Epicycle will be through ten Signs, from *m* to its Perigée in *n*: But the Motion of the lesser Epicycle will be through twenty Signs, to wit, from *a* through *e i o*, its own Circle being wholly run through, and *a e i o*, an Arch of eight Signs, besides. And all these things are exactly alike in the lesser Planets. And in every one of them, the Line A B, or A C, drawn from the Centre of the Deferent to the Centre of the greater Epicycle, is the Line of middle Motion; and the Angle C A *i*, that lies between this and the other Line A *i*, drawn from the Centre of the Deferent through the Body of the Moon, is call'd the Epicyclical *Prosthaphæresis*, and A *i* the Elongation of the Moon from the Centre of the Deferent: Lastly, the Arch of the Deferent between A B and A *i*, or between A B and A *o*, (computed according to the order of the Signs B C D, to A *o*,) is call'd the Anomaly of the Moon, first equall'd.

3. The second Inequality of the Moon is explain'd by a little Circle, whose Diametre A H F, either falls into the Line of the Apogée D A B, or else is parallel to it, and its Circumference passeth through the Centre of the Earth A. In this little Circle is carried about the Centre of the Deferent twice in every Lunation, so that in every true Syzygy, the Centre of the Deferent agrees with the Centre of the Earth A, as in Scheme XXV: But in the true Quadratures the Centre of the Deferent is in F, the point remotest from the Earth, as in Scheme XXVI. it may be seen; where, besides the Lines of the foregoing Scheme, there appears also the Line of the true Motion of the Moon A *e*, drawn from the Earth A, to the Body of the Moon *e*; and the length of it, A *e* is call'd the distance of the Moon above the Earth. But the Angle to the Moon A *e* F, that lies between the Lines drawn from the Centre of the Earth A, and from the Centre of the Deferent F to the body of the Moon, is call'd the *Prosthaphæresis* of the Eccentricity; and the Arch of the Eccentrick between F B and F *e*, or between F B and F *o*, (reckoning according to the order of the Signs B, C, D, to F *o*,) is call'd the Anomaly equall'd: For the single or middle Anomaly here, as well as there, is B C, or the Arch B C D E, from which that other (first equall'd) differs always from the Epicyclical *Prosthaphæresis* C F *e*, or E F *o*.

Figure XXVII. 4. But out of the Syzygies or Quadratures, the Diametre of the little Circle A F, does not (as before) fall into the Line of the middle Apogée D B, but is parallel to it, as may be seen in Scheme XXVII. For let the Centre of the Deferent E, wander as it will through the little Circle A L F E, yet those three Lines, *viz.* the Diametre of the little Circle A F, and the Line of the middle Apogée D B, and that which joyns the Centres of the Epicycles C *n*, will continue parallel. But in this third Case besides the Lines of the foregoing Schemes, there is also found A E R, the Line of the true or monthly Apogée, drawn from the Centre of the Earth A, through the Centre of the Deferent E, so that R is the true Apogée, and S the true Perigée. And since the Motion of the Centre of the Deferent E, *viz.* the Arch of the little Circle A L F E, is always equal to the doubled Arch, that lies between the true place of the Sun and the place of the Moon, first equall'd, (which they call the doubled distance of the Luminaries;) thence 'tis manifest, that the Arch F E, (which in this place is the Excess of the whole A L F E, above the Semicircle A L F,) may be obtain'd, to which is equal the Angle to the Centre E H F; but the half of the same is the Angle to the Circumference F A E, *M. I.* by 20 III. And again, to this is equal B E R, which they call the Angle of

Fig. XX.

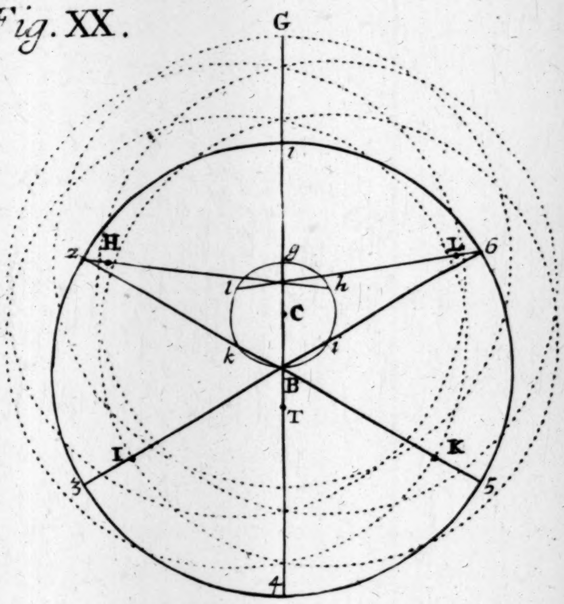


Fig. XXI.

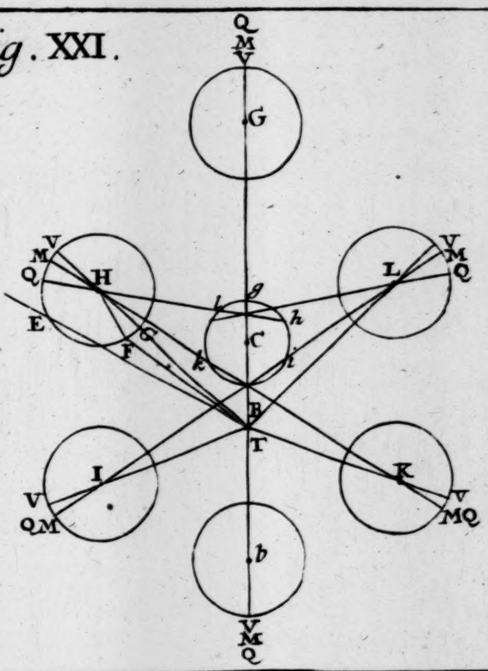


Fig. XXII.

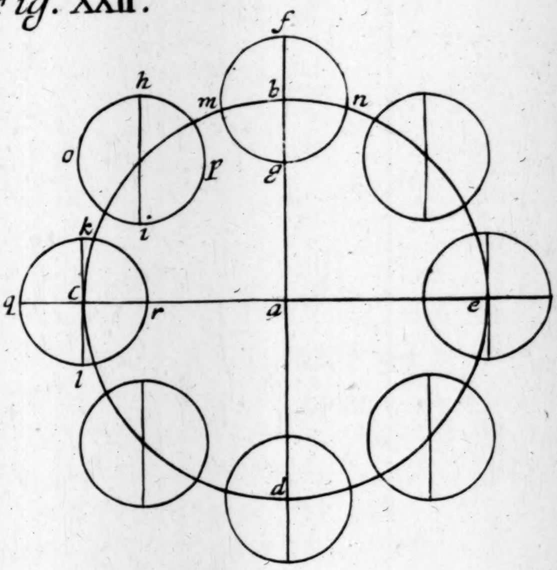


Fig. XXIII.

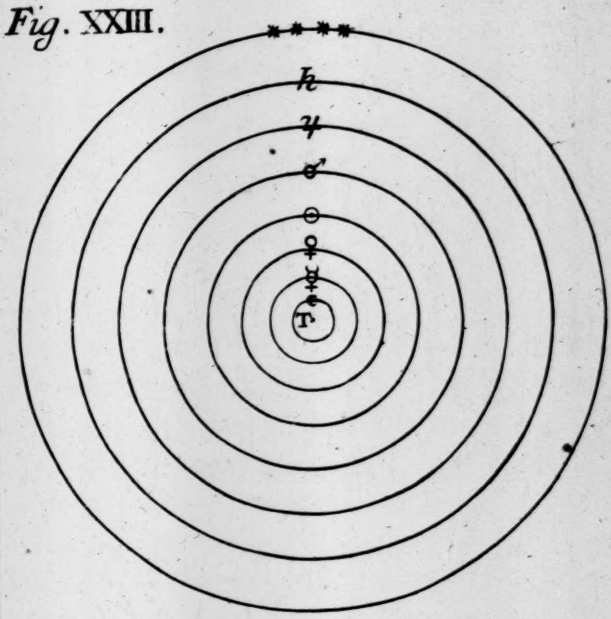


Fig. XXIV.

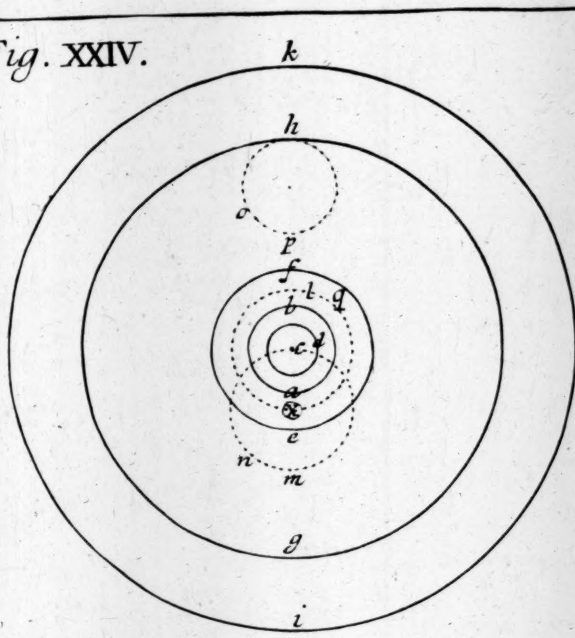
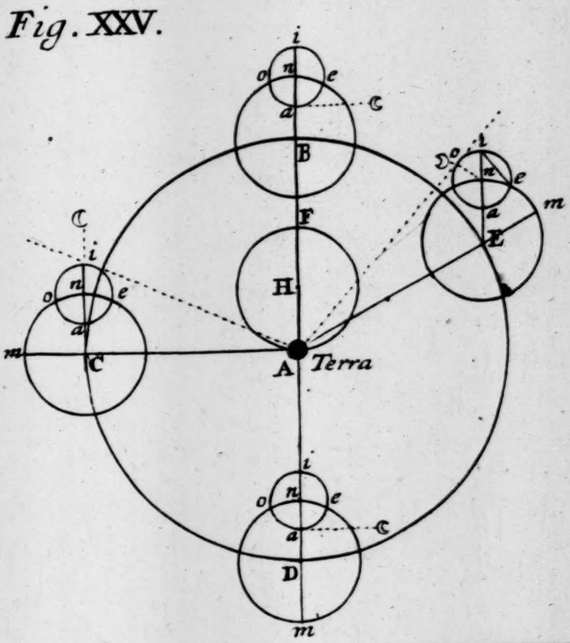


Fig. XXV.



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of the ſecond Equation, with reſpect to the ſingle Anomaly, which is twice to be equall'd: So in this place, the ſingle Anomaly is B C, or B E C the Angle; but the Anomaly firſt equalled, is B E *e*; and the Angle of the ſecond Equation B E R, being ſubtracted from it, there remains R E *e*, the Anomaly equall'd in the ſecond place, lying between the Line of the true Apogée E R, and the other which is drawn from the Centre of the Deferent E, to the Body of the Moon. But beſides, there is farther to be conſider'd the Line A E, that joyns together the Centres of the Earth A, and of the Deferent E, which they call the Eccentricity, and that is ſubtended, or lies under the Angle to the Moon A E *e*, which I have nam'd the *Proſthaphæreſis* of the Eccentricity: For it ſhews the difference that is between the place of the Moon, that is ſeen from the Centre of the Deferent E, and from A the Centre of the Earth; and the Moon going from the true Apogée R, through D, to the Perigée S, it is taken from the Moon's place that is firſt equall'd; as in the other Semicircle S B R, it is added, that in both caſes, the Moon's place that is ſecondly equalled, may be found.

5. But now beſides the Inequalities of the Moon hitherto ſpoken of, *viz.* the firſt Epicyclical, and the other of Eccentricity, *Tycho* alſo found a certain third, but very ſmall one, which never exceeds forty Minutes and ½; and 'tis call'd the Variation, and is nothing elſe but a certain Libration, or wavering of the Centre of the greater Epicycle, whoſe Motion is ſwifter about the time of the Syzygies, and ſlower about the Quadratures: For in every Syzygy, and Quadrature, the Centre of the Epicycle is in C, (in Figure XXVIII.) the Centre of the little Circle; where it would alſo be, if there was no Libration at any time. But in an Octile Aſpect, before the Syzygies, it is in *g*, and goes on from thence; ſo that in the very Moment of the Syzygy it comes to the Point C, and proceeds even to the Octile after the Syzygy into *f*. Now here when the Octile is before the Quadrature, it goes back; ſo at the very moment of the Quadrature, it returns into C, and goes backward ſtill, even to the Octile after the Quadrature into *g*. Now the manner of this Motion of Libration is, as if we ſhould ſuppoſe a certain Point to begin at the very moment to go forward from *s*, with an equal Motion towards *f*; whither it comes in the Octile after the Syzygy, and proceeds from thence, till at the time of the Quadrature it is in *y*, and ſo on. Now from any Point of the Circumference of the little Circle, in which the feigned movable is ſuppoſed to move, let a perpendicular be caſt upon the Diametre of the little Circle *f g*: As for inſtance, the feigned Moveable being in *h*, a Perpendicular let fall, would find in the Diametre of the little Circle the Point *t*, where the Centre of the Epicycle will then be. In the mean time 'tis eaſily underſtood, that this libratory Motion of the Centre of the greater Epicycle, does the ſame way affect not it ſelf only, but alſo the leſſer Epicycle, and the Body of the Moon that is fix'd in it. And this is the Moon's Motion of Longitude according to *Tycho Brahe*. Figure XXVIII.

CHAP. XV.

Of the Latitude of the Moon according to Tycho.

BEſides thoſe things that our Predeceſſors have delivered concerning the Latitude of the Moon, which were built upon the Deviation of the Moon's Orbit, five degrees from the Eclíptick, and upon the Revolution of the Nodes to the Antecedent Signs, which was ſuppos'd to be finiſh'd in about nineteen years time; *Tycho* has farther found out a double Irregularity, the one of which he aſcribes to the trembling of the Nodes that ſometimes move more ſwiftly than ordinary toward the Antecedent Signs, ſometimes go ſomething back into the Conſequent; but the other he attributes to the Orbit that ſometimes inclines, or nodds, as it were, towards the Ecliptick, and again ſometimes declines from it. But both the ſaid Irregularities happen through a wavering Motion, juſt like that attributed to the Variation of the Moon in the foregoing Chapter: For to ſpeak firſt of the former of the two, in Figure XXIX. there is a little Circle to be deſcrib'd from the Node A, which by its middle Motion, tends to the Antecedent Signs towards Figure XXIX.

wards

wards D. In every Syzygy and Quadrature, the true Node agrees with the middle one A, thence it goes on to the consequent Signs towards B, till the Octile after the Syzygy or Quadrature be completed; and so it goes back towards A and C, in the same manner, that the Semidiametres, or the inverted Signs of all the degrees of the little Circle, do increase or decrease, (as was said before concerning the Variation of the Moon,) and the Ray of the little Circle A B, is of one degree and 46′. The other Inequality, *viz.* of the inclining and declining Orbit, is made under a Circle of Latitude, drawn through Bounds 90 degrees remov'd from the Nodes. In every Syzygy, the Angle of the Orbit of the Moon, and of the Ecliptick, or the Arch of the Circle of Latitude drawn through the said Bounds, is at least of 4 degrees 58′. 30″. but in every Quadrature, the same Angle or Arch is of 5 degrees, 17′. 30″. So that the Diametre of the Circle of Libration, is of 19′; and the manner and measure of the Libration (as before) follows the proportion of the inverted Signs, that answer to every degree of the Circle of Libration.

CHAP. XVI.

Of Copernicus's *Sphere.*

HAving now explain'd the chief ***Hypotheses*** of those that will have the Earth to stand still, I now enter upon their *Hypotheses*, that suppose it be mov'd about the Sun. But before the ***Phænomena*** of the secondary Moveables can be explain'd by this supposition, we must first understand, how according to this the first Motion may be demonstrated, that is common to all the Stars, which is otherwise wont to be explain'd by the common Sphere. But here we have need of a Sphere, different from the common one; and we must form our Conception a little otherwise than before, perhaps in this manner: The Centre of the Sun is suppos'd to be the Centre of our planetary World, which is encompass'd on all sides by the Lucid Bodies, which we call the fix'd Stars; which fix'd Stars, how far they are from the Sun, is out of Ken and reach of our Senses and Imagination to comprehend: For who can set any Bounds to the Universe, no bounds of which he could ever yet perceive? Wherefore we make the Sun the Centre, not with respect to the whole Universe, which is unmeasurable, (at least to us,) and therefore has neither middle nor extream; but with respect to our Earth and the rest of the Planets, which are carried round the Sun, as about a Centre or certain middle Point. And the same Sun may be said to be the Centre of the Sphere of the fix'd Stars, not as if this was distinguish'd from the Extramundane Void by certain Surface or outward Crust; but because our Imagination, stretching it self equally on every side from the place where we are, and being unable to comprehend the Immensity, it is bounded on each side into a kind of Sphere. Or if any one had rather extend this Sphere of the World, as far as the Eye is able to go, when assisted by the best perspectives, the Universe will lose nothing of its Immenseness. And now if the Sphere of the fix'd Stars be unmeasurable, it will also for that reason be unmovable. Nay, if you suppose a certain Extramundane Void, yet no man can imagine, how the outmost Surface of the World forsakes one space after another of that Void, where there cannot be so much as any Sign given, by which that departure may be perceiv'd. If therefore the utmost Surface of the World, do not change its Situation, with respect to the void space that is without it, (for we cannot so much as feign such a thing by the strength of Imagination,) but changes its Situation only with respect to the Bodies contain'd within it; What remains, but that we may think the Sphere of the fix'd Stars is immovable, but the enclosed Earth, with respect to the same Sphere, does change its Situation, that is, is really turn'd about its own Axle? Now therefore, whether the Sphere of the fix'd Stars be unmeasurable, or bounded, yet certainly 'tis immovable, and may be said to be of a Spherical Surface, whose Centre the Sun possesses, and never moves out of it, though 'tis found to roll about its own Axle, by the spots which in a certain space of

of time are removed from one edge of its Hemisphere to the other. Now as the Immense Sphere of the fix'd Stars, consider'd in it self, does want a Centre or middle; but, because of the Motion of the Planets, does obtain a Centre, which I have said to be the Sun, rather than the Earth: So also by reason of the same Motion of the Planets, which in a certain Track are mov'd about the Sun as their Centre, the same Immense Sphere of the fixed Stars has a certain Girdle, which we call the Zodiack *i. e.* the Rays passing from the Sun by the Planets that are carried about; all which Rays do fall upon those Asterisms of the Sphere of the Stars, which from the Resemblance of Animals, they call *Zodia.* In the middle of which Girdle, seeing the Earth always walks, as by a certain High-way between the Planets that deviate on each side; therefore that Circle is call'd the Circle that passes through the midst of the Animals, that is, the Circle that goes through the middle of the Signs, (the Plane of the Circle, which the Earth describes, being continued to the Sphere of the fix'd Stars:) And the Area, or plane space, extended on every side between the Circumference, delineated in the Firmament, and the Centre of the Sun, is call'd the Plane of the Ecliptick: And a perpendicular erected from the Centre upon this Plane, is the Axle of the Ecliptick, which, when continued to the fixed Stars, has in its Extremities or Ends, the Poles of the Ecliptick; and these Poles, as also the Ecliptick it self, has always the same Situation with respect to the fix'd Stars. Again, from the Poles of the Ecliptick to the Ecliptick it self, are drawn Circles of Latitude: But as in the Terrestrial Globe, no Meridian is in nature before any other, but only by Men's Institution and Agreement; so among the Circles of Latitude, there is no one the first, but that which men would have so. *Copernicus* draws the first Circle of Latitude through the first Star in *Aries*, and from this computes the Longitudes of the fix'd Stars; which was begun from thence, because about the Age those lived in, that have left us the most antient Observations, the first Star in *Aries* was near the Vernal *Æquinox*. But in the beginning of 1660. the Colure of Solstices was distant from the first Circle of Latitude, drawn through the first Star in *Aries* 61 degrees, 32′, 51″. towards the consequent Signs. Now the other Colure (of *Æquinoxes*) is distant from the Colure of Solstices 90°, to be computed on this side, and beyond in the Ecliptick. But in this the two Colures differ from one another, *viz.* that the Solstitial Colure passes both through the Poles of the Ecliptick, and the *Æquator* too; but that of the *Æquinoxes* goes not through the Poles of the Ecliptick, but only of the *Æquator*. Now the Poles of the *Æquator* are thus found out; from the Pole of the Ecliptick in the same Colure of Solstices, let 23°, 30′. be reckon'd towards the same part of the Starry Globe, where are the bright Heads of *Gemini*; and so where the Account is ended, there is the Arctick Pole of the *Æquator*, to which the Antarctick is diametrically oppos'd. But now as the yearly Motion of the Earth about the Sun, produc'd the Ecliptick; so the daily Motion of the Earth about its own Axle, produc'd the *Æquator*; which is properly a Terrestrial Circle, which any point in the Surface of the Earth, that is on each side equally distant from the Poles, does describe by its daily Motion. But if any one will conceive the *Æquator* to be in the Heavens; then for certain he must not conceive only Mathematical Points, Lines, and Surfaces, that want all profundity; but he must philosophize something more grosly: For all that Sphere, whose Semidiametre is not less than the distance of the Earth from the Sun, is in proportion but a Point or a Centre: And by the flowing of this so gross a Point from the Centre to the Ecliptick, is made the Ray of the Ecliptick, which being carried round, it describes the Area of the Ecliptick, which is indeed of a vast depth, but with respect to the Firmament, it is unperceivable. So likewise, if that gross Point be suppos'd to flow from the Centre perpendicularly to the Plane of the Ecliptick, then the Axle of the Ecliptick is drawn: And so reckoning 23 degrees in the Colure of the Solstices, from the Pole of the Ecliptick, towards the Heads of *Gemini*, there will again appear from that gross Centre at the end of 23°, 30′. an Axle of the *Æquator*, as equally gross or thick, which yet with respect to the vast Firmament, is no more than a bare Line. And so at length, both the *Æquator* and the Tropicks will be conceiv'd to be delineated by gross Circumferences in the Sphere of the fix'd Stars. And now these things being thus suppos'd, in what part soever of its Orbit the Earth is, it will always be in the Centre of the Firmament: For that Centre is as big

as the very Orbit of the Earth. And yet neverthelefs, if any Circle that is drawn in the surface of it (that is, of the Earth,) be divided, as the *Æquator*, for instance, into 360°; there may be drawn from the Centre of the Earth, through every Division that is made in its Surface, to the very Cœlestial *Æquator* right Lines, that will in like manner divide the whole Cœlestial *Æquator* into just so many degrees: And to every degree of the Terrestrial *Æquator* every degree of the Cœlestial ones will answer, as the whole Terrestrial *Æquator* lies under all the Cœlestial, in what part soever of its Orbit the Earth is plac'd. And so also the Tropicks of the Earth will lie under the Tropicks of the Firmament, and the Articks under the Articks. Hence we must know, that the first Circle of Latitude (which goes through the first point of *Aries*) is immoveable; but the Colure of the Solstices comes by little and little towards the first Circle of Latitude, moving with a slow Motion every year 51″ about the Poles of the Ecliptick, that is in 70 years about one degree. And by that Motion it carries about with it the Pole of the *Æquator*, (which is in the Colure of the Solstices;) whence it comes, that also the other Colure (of *Æquinoxes*, which is distant from the Colure of the Solstices always 90,) does creep on together with it towards the Antecedent Signs; And so the Equinoctial Sections do recede from the fix'd Stars towards the Antecedents, the Ecliptick however remaining immoveable; and the *Æquator*, with all its Appurtenances, *viz.* its Parallels and Meridians, which are carried about the Axle of the Ecliptick. And this Motion is wont to be called the Procession of the Æquinoxes. Now the daily Motion of the Earth is from West to East, according to the Order of the Signs about its own Axle; which Axle, while the Centre of the Earth is by its yearly Motion carried around in its own Orbit, does always continue Parallel to it self, excepting only that slow Motion of it about the Axle of the Ecliptick, which has been just now mentioned, which is only 51″ yearly. For wheresoever the Earth is in its Orbit, always the Right Line, drawn from its Centre to the Pole of the Cœlestial *Æquator*, does represent the Axle of the Earth, about which it is moved by its daily Motion. Now how the *Phænomena* of the Seasons of the year, and of the Changes of Days and Nights may be hence deduc'd, I shall explain in what follows. But now as concerning the Motions of the rest of the Planets, First, The Arch of the Planet in the Ecliptick, taken from the vernal Intersection, or the point of the Spring-*Æquinox*, to the Ascending Node, is the Longitude of the Node, which is always equally increased in the other Planets, but in the Moon it decreases equally, because the Nodes of the Moon go backward. Secondly, Moreover from the Ascending Node are reckoned in the Ecliptick 90ᵈ, and from thence to the Pole of the Ecliptick is drawn the Circle of the greatest Inclination. For as the distance of the Sun from the *Æquator* is the greatest in the beginning of *Cancer* and *Capricorn*, which is 90ᵈ distant from either *Æquinox*, and is called the greatest Declination. So the greatest distance of every Planet from the Ecliptick, consider'd as from the Sun, happens in the Northern or Southern Bounds of the Planet's Motion, which are both 90ᵈ distant from each Node, and it is called the greatest Inclination. And now from the Ascending Node through the Northern Bound, is drawn the Orbit of the Planet to be conceiv'd in the Firmament, in whose Plane is afterwards delineated the very Track of the Planet, as it goes about the Sun, which is also call'd more properly the Orbit of the Planet. Thirdly, The Arch that is reckoned from the Ascendent Node to the *Aphelion*, (or place of the Planets farthest distance from the Sun,) when added to the Longitude of the Node, gives the Longitude of the *Aphelion* from *Aries*. And though these two Arches be taken and computed in diverse Circles, the first in the Ecliptick from *Aries* to the Node, and the second in the Orbit of the Planet, that inclines upon the Ecliptick, from the Node to the *Aphelion*; yet seeing both the Motions are regular, one Motion may be compounded of them, which may also be regular, to wit, of the *Aphelion* from the *Æquinox*: For a Regular added to a Regular produces a Regular. 4 Lastly, from the *Aphelion* in the Orbit of the Planet (understand here always that Orbit which is drawn in the Sphere of the fixed Stars) to the Line of the Middle Motion, is the middle Anomaly, but to the Line of the true Motion is the equaliz'd Anomaly, which being added in the first Semicircle to the place of the *Aphelion*, and substracted in the latter, it gives the Heliocentrick place of the Planet, (or the place it is in with respect to the Sun, when taken for the Centre,) which is afterwards to be brought to the Ecliptick, and then the Heliocentrick Place of the Planet in the Ecliptick does appear, namely,

That Point which is found by the Circle of Inclination, that is drawn ugh the Place in the Orbit.

CHAP. XVII.

the Motion of Reflexion of the Earth's Axle, and of the Declination of the Sun that arises from thence.

Figure XXX. let the great Circle ♈ ♋ ♎ ♑ be the Ecliptick of the Firmament, whose Southern Pole *a*, let it be conceiv'd to be turn'd to us, who are suppos'd without the Firmament at an infinite distance, while the other the Northern is hid behind it in the other Hemisphere. Now this Ecliptick ought to be con- d so large, that the whole Orbit of the Earth *b c d e*, with respect to it, may be ider'd as no more but a Point or Centre; which, since it cannot be express'd in ieme, is to be supplyed by the Fancy. Now the Colure of the Solstices is here nto a right Line ♋ *a* ♑. In the Plane of the Ecliptick is delineated the Orbit e Earth, going forward in its yearly Motion from *b* to *c d e*, *&c.* and that so, the Plane of the Earth's Ecliptick, or of the lesser Circle ♈ ♋ ♎ ♑ does per- ally remain in the Plane of the greater Circle, ♈ ♋ ♎ ♑; (not mentioning at nt the Earth's daily Motion about its own Axle:) And all the Signs of the a's Ecliptick do each of them constantly remain under those particular Signs of reat Ecliptick, which bear the same Names, and are never separated from one her, though the Earth's Centre be carried about by a yearly Motion; but by tain magnetical Power every Sign is kept in the same Situation by the Sign e same Names: Therefore ♋ *b* ♑, ♋ *c* ♑, *&c.* will represent the Earth's Sol- l Colure, which passes through the Southern Pole of the Earth's Ecliptick, that n'd towards us, *b*, *c*, *d*, *&c.* and is also hid by the Northern behind *b*, *c*, *d*, *&c.* ikewise through both the Poles of the Earth's *Æquator*, *viz.* the Southern, which rn'd to us in *p*, and the Northern, which is plac'd in *o* in the Hemisphere, is turn'd from us. But if from the Poles of the Earth's Ecliptick, namely, the Southern one *b*, that is turn'd to us, and from the Northern one, which behind *b*, be taken on each side the Distance of 23° ½; And if there be two les- ircles understood to be describ'd of that Interval about both the Poles of the ick, the one *m n o p*, and the other that which lies hid behind it in the He- nere that is turn'd from us: Then (if from the Centre of the Earth there ut on each side a Ray to the Circumference of the said lesser Circles, so that two Rays be extended streight forward into one Diametre; and the middle nt of that Diametre being fixt in the Centre of the Earth *b*, if the ends of Diametre be carried about in the Circumference of the lesser Circles *m n o p*, and t which lies behind it,) there will be describ'd by the Diametre the Surface of two nes, whose tops do come into a Cone in the Centre of the Earth, but the Bases the Planes of the lesser Circles last mentioned, in whose Circumference the Ends the Diametre were carried about; moreover the Plane of the Circle of Illumi- ation that is cast upon the Right Line *m n*, does divide this twofold Cone in the iddle. For wheresoever the Earth is in its Orbit, the Ray that comes from the n *a*, to the Centre of the Earth *b*, *c*, *d*, *&c.* will be perpendicular to the Plane f the Circle of Illumination *m n*, and this same Plane *m n* does divide equally both e twofold Cone and its Bases *m n o p*, and that which lies behind it. And now ese being thus suppos'd, when the Earth is in *b* in the beginning of *Aries*, the Axle the *Æquator o b p*, that extends it self from the Northern Pole *o*, (which is turn'd ay from us,) through the Centre of the Earth *b*, to the Southern Pole, (which turn'd to us,) does then fall upon the Plane of the Circle of Illumination, in hich the Axle *o p* is plac'd for a time. Here therefore, seeing the Circle of Il- mination passes through both the Poles of the Earth, it may be easily imagin'd, at both the *Æquator*, and all its Parallels that are to be describ'd by the daily Mo- on of the Earth, must be cut in two by that same Circle of Illumination; and so at every Point of the Earth does in its daily Motion make one Semicircle parallel to

Figure XXX.

as the very Orbit of the Earth. And yet neverthelefs, if any Circle that is di in the furface of it (that is, of the Earth,) be divided, as the *Æquator*, for insta into 360°; there may be drawn from the Centre of the Earth, through every L fion that is made in its Surface, to the very Cœleftial *Æquator* right Lines, that w like manner divide the whole Cœleftial *Æquator* into juft fo many degrees: And to ry degree of the Terreftrial *Æquator* every degree of the Cœleftial ones will anf as the whole Terreftrial *Æquator* lies under all the Cœleftial, in what part foev its Orbit the Earth is plac'd. And fo alfo the Tropicks of the Earth will lie u the Tropicks of the Firmament, and the Arcticks under the Arcticks. Henc muft know, that the firft Circle of Latitude (which goes through the firft poi *Aries*) is immoveable; but the Colure of the Solftices comes by little and littl wards the firft Circle of Latitude, moving with a flow Motion every year 51″ a the Poles of the Ecliptick, that is in 70 years about one degree. And by that tion it carries about with it the Pole of the *Æquator*, (which is in the Colure of Solftices;) whence it comes, that alfo the other Colure (of *Æquinoxes*, which i ftant from the Colure of the Solftices always 90,) does creep on together wit towards the Antecedent Signs; And fo the Equinoctial Sections do recede from fix'd Stars towards the Antecedents, the Ecliptick however remaining immovea and the *Æquator*, with all its Appurtenances, *viz.* its Parallels and Meridians, w are carried about the Axle of the Ecliptick. And this Motion is wont to be c the Proceffion of the Æquinoxes. Now the daily Motion of the Earth is from to Eaft, according to the Order of the Signs about its own Axle; which A while the Centre of the Earth is by its yearly Motion carried around in its Orbit, does always continue Parallel to it felf, excepting only that flow Motio it about the Axle of the Ecliptick, which has been juft now mentioned, whi only 51″ yearly. For wherefoever the Earth is in its Orbit, always the Right l drawn from its Centre to the Pole of the Cœleftial *Æquator*, does reprefent the of the Earth, about which it is moved by its daily Motion. Now how the *Ph mena* of the Seafons of the year, and of the Changes of Days and Nights ma hence deduc'd, I fhall explain in what follows. But now as concerning the Mot of the reft of the Planets, Firft, The Arch of the Planet in the Ecliptick, c from the vernal Interfection, or the point of the Spring-*Æquinox*, to the Af ding Node, is the Longitude of the Node, which is always equally increafed in other Planets, but in the Moon it decreafes equally, becaufe the Nodes of the M go backward. Secondly, Moreover from the Afcending Node are reckoned i Ecliptick 90ᵈ, and from thence to the Pole of the Ecliptick is drawn the Circ the greateft Inclination. For as the diftance of the Sun from the *Æquator* i greateft in the beginning of *Cancer* and *Capricorn*, which is 90ᵈ diftant from *Æquinox*, and is called the greateft Declination: So the greateft diftance of ev Planet from the Ecliptick, confider'd as from the Sun, happens in the North or Southern Bounds of the Planet's Motion, which are both 90ᵈ diftant from e Node, and it is called the greateft Inclination. And now from the Afcending No through the Northern Bound, is drawn the Orbit of the Planet to be conceiv'd the Firmament, in whofe Plane is afterwards delineated the very Track of the Pl net, as it goes about the Sun, which is alfo call'd more properly the Orbit of the Pl net. Thirdly, The Arch that is reckoned from the Afcendent Node to the *Aph lion*, (or place of the Planets fartheft diftance from the Sun,) when added to t Longitude of the Node, gives the Longitude of the *Aphelion* from *Aries*. And thoug thefe two Arches be taken and computed in diverfe Circles, the firft in the Eclipti from *Aries* to the Node, and the fecond in the Orbit of the Planet, that incline upon the Ecliptick, from the Node to the *Aphelion*; yet feeing both the Moti ons are regular, one Motion may be compounded of them, which may alfo be re gular, to wit, of the *Aphelion* from the *Æquinox*: For a Regular added to a Regular produces a Regular. 4 Laftly, from the *Aphelion* in the Orbit of the Planet (underftand here always that Orbit which is drawn in the Sphere of the fixed Stars) to the Line of the Middle Motion, is the middle Anomaly, but to the Line of the true Motion is the equaliz'd Anomaly, which being added in the firft Semicircle to the place of the *Aphelion*, and fubftracted in the latter, it gives the Heliocentrick place of the Planet, (or the place it is in with refpect to the Sun when taken for the Centre,) which is afterwards to be brought to the Ecliptick, and then the Heliocentrick Place of the Planet in the Ecliptick does appear, name

ly

ly, That Point which is found by the Circle of Inclination, that is drawn through the Place in the Orbit.

CHAP. XVII.

Of the Motion of Reflexion of the Earth's Axle, and of the Declination of the Sun that arises from thence.

IN Figure XXX. let the great Circle ♈ ♋ ♎ ♑ be the Ecliptick of the Firmament, whose Southern Pole *a*, let it be conceiv'd to be turn'd to us, who are suppos'd to be without the Firmament at an infinite distance, while the other the Northern Pole is hid behind it in the other Hemisphere. Now this Ecliptick ought to be conceiv'd so large, that the whole Orbit of the Earth *b c d e*, with respect to it, may be consider'd as no more but a Point or Centre; which, since it cannot be express'd in a Scheme, is to be supplyed by the Fancy. Now the Colure of the Solstices is here cast into a right Line ♋ *a* ♑. In the Plane of the Ecliptick is delineated the Orbit of the Earth, going forward in its yearly Motion from *b* to *c d e*, &c. and that so, that the Plane of the Earth's Ecliptick, or of the lesser Circle ♈ ♋ ♎ ♑ does perpetually remain in the Plane of the greater Circle, ♈ ♋ ♎ ♑; (not mentioning at present the Earth's daily Motion about its own Axle:) And all the Signs of the Earth's Ecliptick do each of them constantly remain under those particular Signs of the great Ecliptick, which bear the same Names, and are never separated from one another, though the Earth's Centre be carried about by a yearly Motion; but by a certain magnetical Power every Sign is kept in the same Situation by the Sign of the same Names: Therefore ♋ *b* ♑, ♋ *c* ♑, &c. will represent the Earth's Solstitial Colure, which passes through the Southern Pole of the Earth's Ecliptick, that is turn'd towards us, *b*, *c*, *d*, &c. and is also hid by the Northern behind *b*, *c*, *d*, &c. and likewise through both the Poles of the Earth's *Æquator*, *viz.* the Southern, which is turn'd to us in *p*, and the Northern, which is plac'd in *o* in the Hemisphere, that is turn'd from us. But if from the Poles of the Earth's Ecliptick, namely, from the Southern one *b*, that is turn'd to us, and from the Northern one, which is hid behind *b*, be taken on each side the Distance of 23° ½; And if there be two lesser Circles understood to be describ'd of that Interval about both the Poles of the Ecliptick, the one *m n o p*, and the other that which lies hid behind it in the Hemisphere that is turn'd from us: Then (if from the Centre of the Earth there go out on each side a Ray to the Circumference of the said lesser Circles, so that the two Rays be extended streight forward into one Diametre; and the middle Point of that Diametre being fixt in the Centre of the Earth *b*, if the ends of the Diametre be carried about in the Circumference of the lesser Circles *m n o p*, and that which lies behind it,) there will be describ'd by the Diametre the Surface of two Cones, whose tops do come into a Cone in the Centre of the Earth, but the Bases are the Planes of the lesser Circles last mentioned, in whose Circumference the Ends of the Diametre were carried about; moreover the Plane of the Circle of Illumination that is cast upon the Right Line *m n*, does divide this twofold Cone in the Middle. For wheresoever the Earth is in its Orbit, the Ray that comes from the Sun *a*, to the Centre of the Earth *b*, *c*, *d*, &c. will be perpendicular to the Plane of the Circle of Illumination *m n*, and this same Plane *m n* does divide equally both the twofold Cone and its Bases *m n o p*, and that which lies behind it. And now these being thus suppos'd, when the Earth is in *b* in the beginning of *Aries*, the Axle of the *Æquator* *o b p*, that extends it self from the Northern Pole *o*, (which is turn'd away from us,) through the Centre of the Earth *b*, to the Southern Pole, (which is turn'd to us,) does then fall upon the Plane of the Circle of Illumination, in which the Axle *o p* is plac'd for a time. Here therefore, seeing the Circle of Illumination passes through both the Poles of the Earth, it may be easily imagin'd, that both the *Æquator*, and all its Parallels that are to be describ'd by the daily Motion of the Earth, must be cut in two by that same Circle of Illumination; and so that every Point of the Earth does in its daily Motion make one Semicircle parallel Figure XXX.

to the *Æquator* in the enlighten'd Hemisphere, and another in the dark, that is, that there is an apparent *Æquinox* throughout the whole World. Farthermore, the Ray *a b* at that time does paſs over the Plain of the *Æquator*, when it is perpendicular to the *Æquator's* Axle *o p*. And whatſoever Line is perpendicular to the Axle, and paſſes through the Centre of the Earth, the ſame is plac'd in the *Æquator*: For the *Æquator* it ſelf is made up, as I may ſay, of innumerable Lines, perpendicular to the Axle, that proceed on all ſides from the Centre of the Earth. And the ſame will alſo happen, when the Earth is under *Libra* in *f*. But under *Cancer* the Earth being in *d*, the Plain of Illumination *m n*, is bor'd through obliquely by the Axle *o p*, which touches the ſide of the twofold Cone; and therefore the Northern Pole *o*, for inſtance, does mount above the Plane of the Illumination *m n*, 23 degrees and ½. You will learn this better from Scheme XXXI. which agrees ſo far with Scheme XXX. that that which this does expoſe to the Eye directly, that other exhibits to be ſeen on one ſide, and on the contrary. Thus the Ecliptick, which in Scheme XXX. appear'd in a whole Circle, in Scheme XXXI. is caſt into a right Line ♋ ♈ ♑, which is to be underſtood as well of the great Ecliptick, as of the Ecliptick of the Earth. And again, that which in Scheme XXXI. appears a whole Circle, namely, the Colure of the Solſtices ♋ *a* ♑; that in Scheme XXX. is caſt into a right Line. Therefore I now ſay in Scheme XXXI. that *o p* the Axle of the Earth, when under *Cancer*, do paſs obliquely through the Plane of the Circle of Illumination *q y*, and the Northern Pole *o* does mount above the Plane of Illumination *q y*, the quantity of the Angle *o* ♈ *q*, 23° ½, which degrees are meaſur'd by the Arch *q o*, which is that portion of the Colure of the Solſtices *q o* ♋, that lies between the Poles of the Ecliptick *q*, and of the *Æquator o*. For it is worth noting, that the Circle of Illumination does always paſs through the Poles of the Earth's Ecliptick; which is evident from Scheme XXX. where I made ♈, ♋, ♎, ♑, the Earth's Ecliptick, and its Southern Pole *b c d*, *&c.* behind which, both the Northern lies hid, and alſo the Plane of Illumination *m n*, which always goes through both Poles. Now returning to Figure XXXI. we ſhall find that the Ray, which joins the Centres of Sun, and of the Earth ♈ ♋, does go through the Earth's *Æquator* 90 270, with the ſame obliquity of Angle ♑ ♈ 270, with which the Axle *o p*, did alſo make an hole through the Plane of Illumination *q y*; and that the Declination of the Sun, (which under *Aries* is none at all, the Ray that goes through the Centre, paſſing juſt over the Plane of the *Æquator*,) is now the greateſt, *viz.* 23° ½. For as much as the Axle of the Earth *o p*, does riſe higher than the Plane of Illumination *q y*; juſt ſo much does alſo the Ray that joins the Centres ♈ ♑ ♈, riſe above the Plain of the *Æquator* 90 270, that is, the Sun declines juſt ſo much from the *Æquator*.

Figure XXXI.

For the Circle of Illumination, and the *Æquator*, are the greateſt Circles of the Terreſtrial Sphere; and to the latter of them its own Axle is Perpendicular, and to the former, the Ray that joyns the Centres; and conſequently both theſe being Perpendicular, each of them will find the Poles of its own Circle in the Surface of the Earth. Why therefore may not the Pole of the *Æquator o*, be as far diſtant from the Circle of Illumination *q y*, as the Pole of the Circle of Illumination ♑, is diſtant from the *Æquator* 90, 270? For the part 4270, which is common to both, being taken from the Quadrants, (or Quarters of the Circle,) 270, and *q* ♑, then *o q*, and 27 *o* ♑ remain equal. It will be profitable to remember this hereafter. And there is alſo the ſame reaſon, when the Earth is under ♑: But the Earth being out of the Cardinal Points for inſtance in *c*, in Scheme XXX. the Pole *o* is then alſo above the Plane of Illumination *m n*, but not all out 23°. ½. which that it may be the more readily underſtood, I will firſt of all explain the Motion of Reflexion, ſeeing we have now all things ready that belong to it. Imagine therefore the Plane of Illumination to cut both the Baſes of the double Cone; and call the common Section of the Plane of Illumination, and of the Baſis of the Cone, the Fiſſure of the Baſis. Now the Northern Pole of the Earth *o*, is always in the top of the Baſis that is turn'd from us, and the Southern *p* is always in the bottom of the Baſis that is turn'd to us: 'Tis plain then, that the Earth being in *b*, the Pole *o* falls upon the Fiſſure *m n*, of the Baſis that is turn'd away; the Earth being in *c*, the Pole *o* has left the Fiſſure *m n* of the averted Baſe, the ſpace of the Arch *n o*; the Earth being in *d*, the Pole *o* has now left the Fiſ-

ſure *m n*, a Quarter of a Circle *n o*; the Earth being in *e*, the Pole *o* has now left the Fiſſure *m n*, more than a Quarter, namely, the Arch *n o*; and ſo the Arch *n o*, (which is to be computed contrary to the order of the Signs ♈, ♋, ♎, ♑,) will increaſe on more and more, till by that Motion of Reflexion of the Pole *o*, moving all along more and more from *n*, contrary to the order of the Signs, does at laſt go its Round, the Earth being carried about through *f g h i*, into *b*, where the Pole *o* is again join'd with the end of the Fiſſure *n*. The ſame may be imagin'd of the Southern Pole *p*, the end of the Fiſſure of the Baſis, that is turn'd towards us, departing likewiſe more and more from *m*, contrary to the order of the Signs, till the Earth being return'd into *b*, the Pole *p*, and the end of the Fiſſure be join'd again. And this is the Motion of Reflexion, as *Copernicus* call'd it; by which it comes to paſs, that the Axle of the Earth always continues in the ſame Paralleliſm, with the Fibres or ſtreight Lines of the groſs or thick Axle of the Cœleſtial *Æquator*, deſcrib'd in the XVI. Chapter.

For neither is it to be conceal'd, That that ſlow Motion (by which in Scheme XXXI. the Axle of the Cœleſtial *Æquator* O P, does with the end O, for inſtance deſcribe the Circle O 7, about the Pole of the Ecliptick Z, of which alſo I made mention in the XVI Chapter, that that ſlow Motion, I ſay, does likewiſe affect the Earth's Axle *o p*, which, as I ſaid, does always keep the ſame Paralleliſm with that thick Axle O P.

For thence it is, That in Figure XXX. the Pole of the Earth *p* or *o*, do not in a Sidereal year, run all out through the whole Circle *n o m p*; but only reaches every year a Point 51″ on this ſide; namely, juſt ſo much as the Axle declines from its paralleliſm in the ſame ſpace of time. Now therefore ſeeing 'tis evident, that for example, the Pole *o* does ſometimes fall upon the Fiſſure *m n*, and that the Plane of Illumination is the cauſe of this, and ſometimes it is more elevated: It may therefore be deſir'd to be known, how great in every moment is that Elevation or Eminency of the Pole *o*, above the Plane of Illumination, and its Fiſſure *m n*. We muſt know therefore, that the Motion of Reflexion, or the Arch *n o*, when the Earth is for inſtance in *c*, is always equal to the Motion of the Centre of the Earth in the Orbit, or to the Arch *b c*. For ſeeing the Diametre of the great Ecliptick ♋ *a* ♑, is always parallel to the Diametre of the Earth's Ecliptick ♋ *c* ♑, and the Ray *a c* which joyns the Centres, does always fall upon theſe parallels, 'tis plain, the Alternate Angles *p c a*, and *c a d*, are equal, wherefore alſo their Complements *p c m*, (or *o c n*) and *c a b* will be equal. Therefore there being given the Arch *n o*, equal to the Arch *b c*, there may be found no Perpendicular *o s*, that falls from the Pole *o*, to the Fiſſure *m n*, by ſaying: As the Ray is to the Sign of the Angle *o c n*, ſo is *c o* the Sign of 23° ½, to *o s*, the Sign of the Elevation, or Eminency of the Pole above the Plane of Illumination, to which is equal the Eminency of the Ray *a c* above the *Æquator*, or the Declination of the Sun, which I will'd you to remember from what went before.

CHAP. XVIII.

Of the Seaſons of the year, and the Change of Days and Nights.

HOW it happens, that when the Earth is under *Aries* or *Libra*, there are equal Days all over the World, I have explain'd in the foregoing Chapter: Now in Figure XXXI. let the Earth be under *Cancer*, the Ray of the Sun ♈ ♑ ♈, falls directly upon the Tropick of *Capricorn* ♑ *u l*, one Point of which after another, as the Day goes on by little and little, will meet directly with the Sun, which conſequently will be Vertical to every Point in order. And ſeeing the Circle of Illumination is *q y*, dividing the Tropick of *Capricorn* into the greater ♑ *u*, and *u l* the leſs; 'tis plain, that all the Points of this Tropick are longer in deſcribing the greater part ♑ *u* by their daily Motion, than in the leſs *u l*, that is, they

they stay longer in the enlighten'd Hemisphere, than in the dark one; and so in them, the Day is longer than the Night. And by how much any parallel is the more distant from the *Æquator* 90 270, towards the Southern Pole *p*; so much the more unequal will its Division be, and the greater part will be enlighten'd, and the Day for that reason will be the longer; till you see the Antarctick *x y*, wholly withdraw it self from the dark Hemisphere, and in all its Revolution remain in the Light, with all the Southern Zone *x p y* included in it. And since 'tis clear from Scheme XXX. that the Southern Pole *p*, the Earth being under *Aries* in *b*, begins to decline from *m n*, the Plane of Illuminations, and to depart from the same, inclining towards the Sun *a*; while the Earth is in *c d e*, that is in the Northern Signs, where you shall always find *p* plac'd between *m n* and *a*: You may therefore easily understand, that all that time, the Southern Pole remains turn'd towards the Sun; as on the contrary, *o* the Northern Pole at the same time remains turn'd from *a* the Sun, beyond the Plane of Illumination *m n*; whence it must needs come, that the Pole *p* must be six whole Months in the Light, while the Pole *o* is hidden with darkness. But on the contrary, while the Earth goes through the Northern Signs from *f* through *g h i*, even to *b*; the Northern Pole *o* is turn'd to the Sun *a*, on this side, the Plane of Illumination *m n*, but the other *p* beyond *m n* is hidden; whence by way of alternate change, the contrary will happen, namely, a day of Six Months to the Pole *o*, and a night of as many Months to the Pole *p*. Let us return now to Scheme XXXI. that we may finish this whole Speculation. The Earth being under ♋, I said, the Tropick of *Capricorn* ♑ *u l*, in its greater portion *Capricorn u*, and the whole Antarctick *x y*, is in the enlighten'd Hemisphere *q* ♑ *y*. But on the other side, there you see the Tropick of *Cancer k t* ♋, in its lesser portion, and the Arctick *q w*, to be in no measure enlighten'd by the Sun, that is plac'd in the Centre of the Ecliptick behind ♈, and so that every point of the Tropick *k* ♋, is longer in passing through the greater portion *t* ♋ in its daily Motion, than in passing through the less *k t*, that is, it is longer in Darkness than in Light. But again, the Earth being plac'd under ♑, the Ray of the Sun ♈, ♋, ♈, falls directly upon every Point of the Tropick of *Cancer* ♋ *t k*, as it meets with them one after another; and the greatest part of it ♋ *t*, and so the whole Arctick *q w*, with the Northern Frigid Zone *q o w*, that are included in it, are in Light; while on the other side, the greater part of the Tropick of *Capricorn* ♑ *u*, and the whole Antarctick *x y*, with the Southern Frigid Zone *x p y*, that is included therein, are in Darkness.

CHAP. XIX.

Of Equation of Time in the Systeme wherein the Earth is suppos'd to move.

Figure XXXII.

IN Figure XXXII. let there be a projection of the Copernican Sphere, the Eye being suppos'd to be plac'd in the Axle of the World, and looking at an infinite distance directly upon the Southern Pole of the *Æquator*, the *Æquator* will appear as a Circle, whose third Quadrant or fourth part is ♎ 270, and the Ecliptick will fall into an Oval Figure, whose Quadrant let ♎ ♑ be suppos'd to be. Let ☉ be in the Centre of the Sphere, and in the Ecliptick let the middle place of the Earth be mark'd in M, and the true place in V. For nothing hinders, but we may advance the Earth out of its true Orbit, which it has in the Region of the Planets, according to the Line of its middle and true Motion to the very Firmament, if so be it be but understood, to move there in its daily Motion about its own Axle, just after the same manner as before. And in this mean while 'tis plain, that the Earth's *Æquator*, as also that of the Heavens, is cast into a Circle, and all the Meridians, as likewise the Circles of Declination, do appear as it were Right Lines. Therefore the Circle of Declination will be drawn through V, the true place of the Earth, and will be the Line ☉ V *r*, marking in *r* the Right Ascension of the Earth. Farthermore, in the Colure of the

Fig. XXVI.

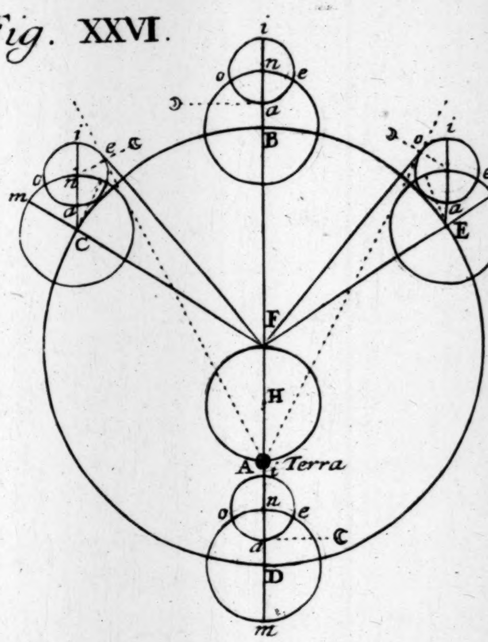


Fig. XXVII.

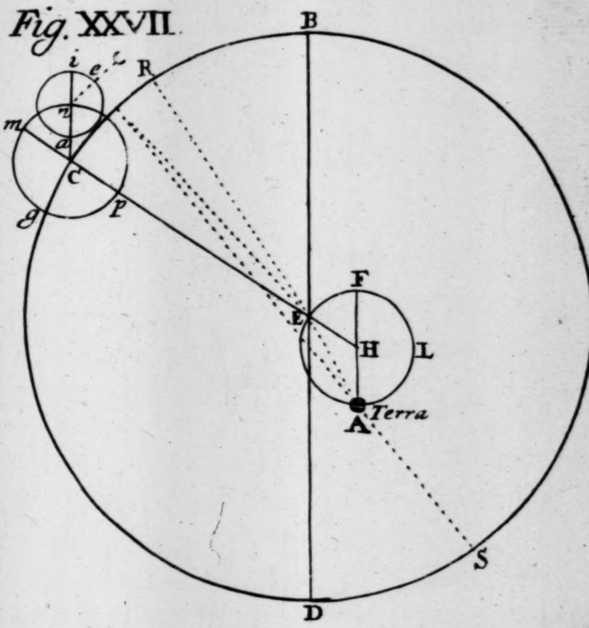


Fig. XXVIII.

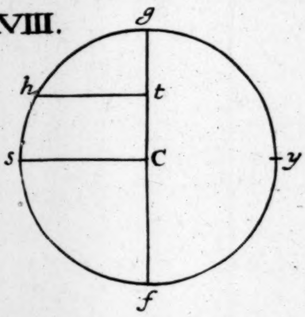


Fig. XXIX.

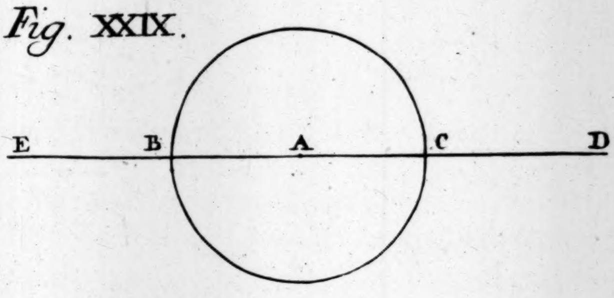


Fig. XXX.

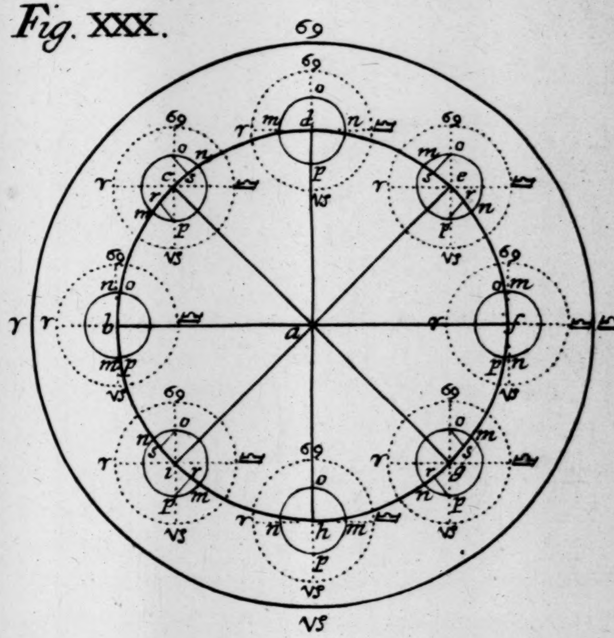


Fig. XXXI.

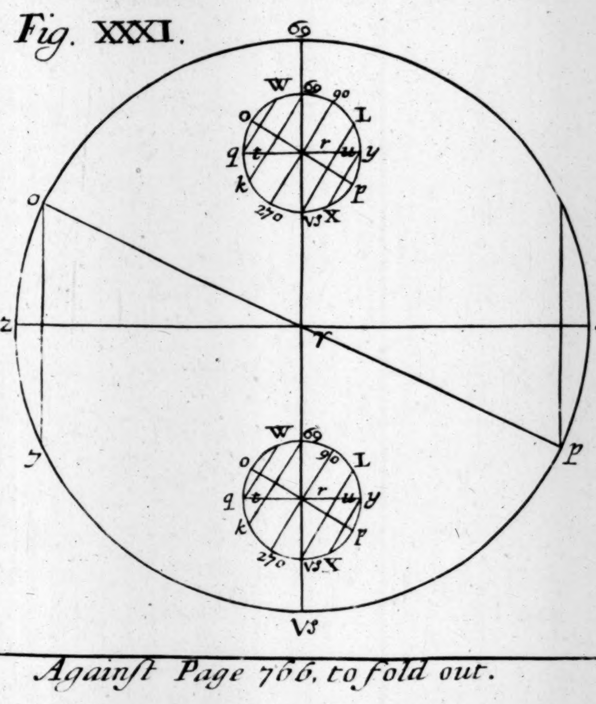
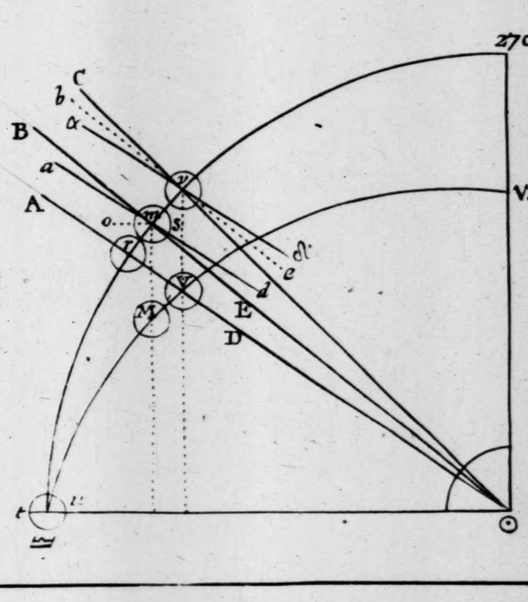


Fig. XXXII.



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the Solstices ☉ ♑ 270, the lesser parallel Circles drawn through M and V, that is, through the middle and true place of the Sun, will reduce them both to the *Æquator*, to wit, to the Points *m* and *v*, which, are as far distant from ♎, as M and V are: And so *m* will be the Feigned Earth, which, in like manner as the Feigned Sun in the third Chapter, is to moderate the Equable or Astronomical Time, its Yearly as well as daily Motion, being suppos'd to be as regular as is possible. And the Regularity of the yearly Motion is perceiv'd, if the Centre of the feigned Earth *m* be suppos'd to move every day the same space in the *Æquator* ♎ 270; but the Regularity of the daily Motion in this, that wheresoever the Earth is in its true Orbit, every Meridian of it always moves around in the same space of time, to the same Parallelism with the Colure of the Equinoxes ♎ ☉; which Revolution would also restore again the same Meridian to the Sun, if it had no yearly Motion, and the Centre *m* would always be in the same Point of the *Æquator*. But now, while the Centre of the Earth is mov'd from ♎ to *m*, 'tis not enough, that the Meridian *o s*, being carried about by its daily Motion, should return to the same Parallelism with the Line ♎ ☉: For the Meridian *t u*, which, when the Earth was in ♎, was directed towards the Sun, the Earth being mov'd on to *m*, though it return to its Parallelism *o s*; yet it is not as yet directed towards the Sun, till *o s* be carried a little farther, so that it falls into the same right Line with B *m* E ☉. For just so much, as the Centre of the Earth has gone on from ♎ to *m*, ought the Meridian *o s*, to go beyond the Parallelism that it obtain'd with *t u*, before it can fall in with B *m* E ☉, and be directed towards the Sun; since the Angles ♎ ☉ *m*, (or the Arches ♎ *m*,) and B *m o*, (or *s m* ☉,) are equal. Whence it follows, that the daily Motion of every Meridian from Sun to Sun, does amount to a perfect Revolution to the same Parallelism with ♎ ☉, and moreover to a portion of the same Revolution, that is equal to the Motion of the Earth's Centre, that is to be made from *Æquinox*, while that same Meridian rolls about again to the Sun. But farther, let us suppose the true Earth, being in the Ecliptick in the point V, to have its Revolution about its own Axle, govern'd by the same Law of Regularity, as the feigned Earth in *m*; to wit, that any one Meridian of the true Earth V, which is once parallel to any one Meridian of the feigned Earth *m*, will always remain parallel to the same; which is likewise to be understood of the Earth, when plac'd by Fiction or Imagination in any other Point, as for instance in M, *r*, *v*, *&c.* And now from hence 'tis easie to understand the Equation of time, which is nothing else but the Arch of the *Æquator r m*, that lies between *r*, the right Ascension of the true Earth that is plac'd in V, and between *m*, the feigned Earth, and which is turn'd into Time: To which is equal the Angle *r* ☉ *m*, or that which is alternate to it, E *m d*, or B *m a*. For when the parallel Lines A D, *a d*, α δ, do through the Antecedent Signs, bring back again the Plane of the same Meridian of the Earth, that is feign'd to be in *r m v*; yet it appears, that only the Meridian A D is directed towards ☉ the Sun, from whom the other *a d* is as yet distant the Angle *d m* ☉, and the Third α δ, a greater still, *viz.* δ *v* ☉; whence it is, that when A D the Meridian of the true Earth V has reach'd the Sun, the Correspondent Meridian of the feigned Earth *a d*, has not as yet come to the Sun, and so the true Noon-day does come before the Equable or Astromical one, the Angle *d m* ☉, or *m* ☉ *r*, or lastly, the Arch *m p*, as I said before. But here also, as in the third Chapter, the Arch *r m* is always either the summ or the difference of two Arches, the one of which is the difference of the true Motion of the Earth, and of its right Ascension, and the other is the difference of the true and middle place of the Earth. So in this Example, the difference of the true Motion of the Earth ♎ V or ♎ *v*, and of its right Ascension ♎ *r*, is *r v*; and the difference of the true and middle place of the Earth, is M V or *m v*: Therefore now if from *r v*, you take *m v*, there remains the Arch of Equation *r m*; or if from the Angle α V C, you take the Angle *b* V C, there remains the Angle of Equation α V *b*, or *a m* B, that is to be turn'd into Time; which will be the difference between the Apparent and middle Noonday or any other hour.

CHAP.

CHAP. XX.

Of Kepler's *Hypothesis.*

HAving thus explain'd the Spherical Doctrine of the System, wherein the Earth is suppos'd to move, the next thing to be done is, that I explain the *Phænomena* of the second moveables by fit *Hypotheses* in the same System. And here I shall wave *Copernicus*'s Circular *Hypothesis*, as being too disagreeable; as also the Circular *Hypothesis* of *Lansbergius*: And shall follow only the Elliptical ones, since *Kepler* in his Commentaty concerning the Planet *Mars*, has sufficiently proved, That no other Orbits but Elliptical will serve for the accurate and exact Explication of the Motion of the Planets. Now the chief *Hypothesis* among the Elliptical ones is *Kepler*'s, who supposes the Sun to be placed in the lower Focus of the Elliptical Orbit of every Planet, and that by its rolling about its own Axle in about 27 days, it carries about the Planets that are plac'd around it, by virtue or force of its Rays, as if it were by a kind of a Leaver; And those that are nearer, it carries the more swiftly, and those that are farther off, the more slowly; just as a Leaver lifts up a weight that is nearer to the moving power with the greater force. Whence it would have come, that, if every Planet always kept the same Distance from the Sun, it would move by a Motion that would be altogether regular: But seeing our Author does conclude, that the Bodies of the Planets are furnish'd with magnetical Fibres, which with one end do tend towards the Sun, and with the other do flee from it; it follows that they sometimes go farther from the Sun, and at other times come nearer, according as they turn their agreeing or disagreeing Pole towards it. Whence it consequently follows, that the Planet which goes farther off, is carried about the more slowly by the weaker power of the Sun's Rays, and on the contrary when it is otherwise: And all this in this manner and measure, that the Area, which the carrying Ray, that is extended from the Sun to the Planet, does brush or pass over, do increase equally in equal Moments of Time. In Figure XXXIII. let A be the Sun, and also the lower Focus of the Elliptick, let L be the other Focus, B the Centre of the Elliptick, and the Elliptick it self P E X I, which the Planet moves in, in its Motion about the Sun. Let there be a Circle drawn about the Sun P D X T. The Line of the Apses is extended through the Focusses A and L, and is X A L P; The *Aphelium* is P, and the *Perihelium* X, and A B is the Eccentricity, and the length of it doubled is call'd the Distance of the Focusses. The greatest Distance of the Planet from the Sun is A P, and the least A X, and the middle distance A E, which is the Arithmetical middle between A P and A X, and also equal to the Semidiametre of the greatest Elliptick B P; but the least Semidiametre is B E. If the Planet be in C, the carrying Ray will be A C, extended from the Sun A to the Body of the Planet. 'Tis certain, that this Line A C, or the carrying Ray, does pass over all the Area of the whole Elliptick, while the Planet returns from P through C E X I, to P again, after it has perform'd its whole Revolution. So while the Planet descends from P into C, the same carrying Ray A C does pass over, as it were brushing or sweeping the Area P A C, that lies between the Line of the Apses A P, the carrying Ray A C, and the Arch of the Elliptick P C. Now I say, This is the Law or manner of the Motion, that as the Time of the whole Revolution, in which the Planet goes about from P to P, is to the Time in which it descends from P into C; so also is the Area of the whole Elliptick P E X I P to the Area P A C: So that the Times, in which the Planet C proceeds, and the Area which the carrying Ray does in the mean while pass over, have each of them the same proportion to their several Integers or wholes. And for this reason the middle Anomaly is not by *Kepler* expressed by an Arch, or by any Angle, as it commonly is; but either by Times, as these are three hundred and sixty parts of the whole Period or Revolution; or else by the *Area*, (for instance P A C,) which the carrying Ray does pass over, as these are also three hundred and sixty parts of the whole Area P E X I P. For why may we not divide the whole Periodical Time, or the whole Area of the Elliptick, as well as the Circumference, into 360 parts, which

we may afterwards call degrees, and subdivide them into lesser Parts? Why may we not also give the Name of Anomaly either to the Time, or to an Area, as well as to Arches and Angles, seeing Names are given to Things according to the pleasure of their Inventors? And here, lest it should seem difficult to any one to find the Quantity of the Area P A C, as it is a portion of the Elliptick; *Kepler* has found out a Remedy for this, by putting for a portion of the Elliptick P A C the portion of the Circle P A K; to wit, by drawing a perpendicular through the Planet C to the Line of the Apses C L, (which they call the ordinated Line) and by continuing it to the Circumference of the Circle that is drawn in K, and by making it A K. Now I say, That the part of the Circle P A K hath the same proportion to the whole, that the part of the Elliptick P A C has to the whole Elliptick; for the part of the Circle P A K being divided into two parts, P L K, and K L A, and also the part of the Elliptick P A C into two parts, P L C, and C L A; first the Area P K L has the same proportion to the Area P C L, that K L has to C L, or that D B has to E B; and so the very same, that each of the ordinated Lines of the Circle have to the ordinated Lines of the Elliptick: For the Area, as well of the Circle as of the Elliptick, is made up, as it were, of their innumerable ordinated Lines, which have been already said to have the same proportion one to onother. Whence it is, that not only the Semicircle P D X has the same proportion to the Semi-Elliptick P E X, that D B has to E B; but also the whole Circle has the same to the whole Elliptick, and the portion of the Circle P K L to the portion of the Elliptick P C L. And also the Triangles K L A and C L A bear the same proportion to one onother, that their Altitudes K L and C L do: And therefore the compos'd Area P A K has the same proportion to the composed Area P A C, that K L has to C L; or that the whole Circle has to the whole Elliptick; And for the Surface P A C may be substituted the surface P A K, if so be at the same time for the whole Elliptick be substituted a whole Circle, which must now be understood to represent the middle Anomaly, and is likewise to be divided into 360 degrees, as the Elliptick has been divided above.

It remains now, that to every middle Anomaly, for instance, to the Surface P A C, we find out an agreeable Anomaly co-equall'd to it, to wit, the Angle P A C, that lies between the Line of the Apses and the carrying Ray. Now this, neither *Kepler*, nor any other after him, could ever find out by a direct way; yet we want not a way whereby it may be come to indirectly. For the Arch P K, which is cut by the Line L C K, that is ordinated or directed through the Planet, he takes to be of as many Degrees as he pleases, and calls it the Anomaly of the Eccentre. Then he seeks an agreeable Area P A K, as the middle Anomaly, and also the Angle P A C, as the co-equall'd Anomaly. Whence he afterwards infers, that seeing the Anomalies so found, as well the middle as the co-equall'd, do agree with the same Anomaly of the Eccentre, it cannot be but they must mutually answer one another. Now the Method is this, First, The Anomaly of the Eccentre P K, is taken to be of as many degrees as you please, the middle Anomaly, that agrees with it, or belongs to it, is the Surface P A K, that consists of two parts, P B K, and K B A. And the Area of the Sectour P B K is the same part of the whole Circle, that the Arch P K is of the whole Circumference; but the Area of the Triangle K B A is equal to the Altitude K L, drawn into the half of B A.

Now L K is found, when first B D, the Ray of the Circle, is known, whose Area contains 360°, 'tis found by saying, As 22 to 7, (or as 314159 to 100000) so is the Area of the Circle to the Square of the Ray or Semidiametre. Then you must say, As the Tabular Ray to the Ray D B, lately found, so is the *Sign* P B K to K L. But also B A is to be found in like parts, by saying; As the greatest Semidiametre of the Elliptick of the Planet D B, is (in parts of which the middle Distance from the Sun is 100000) to the same D B, as a Ray of the Circle that contains an Area of 360°; so is A B, the Eccentricity, to the same A B, which answers to the Area of the whole Circle 360°. And then again, for finding the coequall'd Anomaly, *viz.* the Angle P A C; first in the Triangle K B A there are given K B, B A, and the Angle P B K, whence also will appear the Angle B A K. But farther, as D B, the greatest Semidiametre of the Elliptick, is to E B, the least Semidiametre; so is K L, the Tangent of the Angle K A L, newly found, to C L, the Tangent of the sought-for Angle P A C. As for Example: In *Mars* let the Anomaly of the Eccentre P K be suppos'd to be of 60°: let the middle Anomaly

that answers it be sought after, *viz.* the Surface P A K; and also the co-equall'd Anomaly, the Angle P A C. Out of the *Rudolphine* Tables, which are added at the latter end of this Book, there is given the Log. of the greatest Distance of *Mars* from the Sun, 4.22131, and its absolute Number 16646 is the very A P: So the Log. of the least Dist. is 4.14060, whose Absolute 13823 is A X. A P − A X = A L = 2823; therefore A B = 1411.5: Therefore also A B + A X = B X = 15234.5. In the Triangle B A K are given B K = 15234.5, B A = 1411.5, and P B K the external Angle = 60°; there is found B A K = 55.615. The Rule is; As the greatest Distance A P is to the least A X; So is the Tangent of half the Anomaly of the Eccentre (*i. e.* the Tangent of ½ P B K) to the Tangent of ½ X < <. That is, Always add 991929 to the Tangent of ½ the Anomaly of the Eccentre; The Summ, the Semidiametre being subtracted, is the Tangent ½ X < <. Then the half of the Anomaly of the Eccentre + ½ X < < = B A K. For the finding of the least Semidiametre B E in the Triangle A B E are given A B = 1411.5, A E = 15234.5, and A B E the right Angle. There is found, First, the Angle A E B = 5.32. Secondly, B E = 15169. Then say, The Log. of the greatest Semidiametre 4.18283 gives the Log. of the least Semidiametre 4.18096; therefore the Artificial Tangent of the Angle B A K newly found out, gives the Artificial Tangent of the Angle B A C, which is the very co-equall'd Anomaly 55.50. Or, always add 999813 to the Tangent B A K, the Summ, the Semidiametre being subtracted, is the Tangent B A C. Then for the finding the middle Anomaly, or the Surface P A K, first, the Sector P B K is 60°, to wit, the same part of the Area of the Circle, that the Arch P K is of the Circumference. But the Ray D B of the Circle, whose Area is 360°, is found by saying,

Absolute Numbers.	*Logarithms.*
As 314159	5.49715
is to 100000,	5.00000
So is the Area 360°	2.55633
to the Square Root,	2.05915
Therefore the Root, &c.	1.02958

Again:

As the Logarith. of the mid. dist.		is to the Log. of Eccentricity		So is the Root D B from the Area 360°		to the Eccentricity A B from 360°
4.18283	:	3.14958	: :	1.22958	.	$\bar{1}$.99643.

And by taking away the Log. of two 0.30103

There remains the Logarithm. ½ A B $\bar{1}$.69540.

Farther:

As the Tabular Ray is to the Ray from the Area of 360; so is the Sign P B K, to K L from 360° 10.00000. 1.02958 :: 993753. 0.96711.

Taking away the first Term from the second, there always remains 9.02958 to be added. Lastly, K L in ½ A B = to the Area K B A; and in the Logarithms 0.96711 + $\bar{1}$.69540 = 0.66251. And seeing the first of the Components, namely, 0.96711 equals 9.02958 + the Sign P B K (as was just now said) the compounded Number will be 0.96711 = 9.02958 + the Sign P B K + $\bar{1}$.69540 = 10.72498 + the Sign P B K. Wherefore for finding the Area of the co-equalizing Triangle, the perpetual Rule is this: Always add 10.72498 to the Artificial Sign of the Anomaly of the Eccentre, the Summ is the Logarithm of the Area K B A; which you must add to P B K, an Area of as many Degrees, as the Anomaly of the Eccentre P K consists of, and you will have the whole surface P A K, which we call the middle Anomaly.

Now to the Logarithm of the *Area* K B A 0.66251 does answer the absolute Number 4.5974, that is to be added to the Area P B K of 60°, and there is made the Area P A K 64.5974.

And

And now from the middle Anomaly 64.5974 take the co-equall'd Anomaly found above ——— ——— 55. 50.

There remains the *Prosthaphæresis* 9. 0974.

Also the Table of Equation of the Centre of *Mars* does give the same to the same middle Anomaly; whence is manifest the way that all those Tables of the Equation of the Centre were made. In this *Hypothesis* of *Kepler* some disapprove only of this, That from the middle Anomaly, when given, he deduces the co-equall'd Anomaly only by an indirect way; commending at the same time both its Agreement with the Heaven's, and the handsome way of demonstrating Motions from their Causes; which indeed *Kepler* valued so much, (not without the Approbation too of all candid Judges,) that he chose rather to follow an indirect Method of Computation, than to devise another *Hypothesis* less agreeable to Nature: For they that object against Him an Ungeometricalness in the *Hypothesis*, have not yet solv'd his Problem; and they seem to be deceiv'd, as if they believe, that even an indifferent Geometrician might not find out a way to solve *Phænomena à priori*, from their Causes; except he had studied that which was to no one's damage, but was well approv'd by many, namely, to explain the natural Causes of the Motions.

But omitting these, I shall give you from *Kepler* the Dimensions of the Orbs of every Planet, taken in parts, of which the middle distance of the Earth from the Sun is 100000.

	The Interval.				
	Aphelion.	*Middle.*	*Perihelion.*	*Eccentricities.*	
Of *Saturn*	1005207	951000	896793	5700	Of such as the Semidiametre of the Orb of the Planet is 100000.
Of *Jupiter*	544701	519650	494592	4822	
Of *Mars*	166465	152350	138235	9263	
Of *The Earth*	101800	100000	98200	1800	Of such as Semidiam. of the yearly Orb is 100000.
Of *Venus*	72900	72400	71900	694	
Of *Mercury*	46955	38806	30657	2100	

Nor must we conceal here the most admirable Theorem of the same Author, wherein he shews, that the Periodical Times of the Planets, compar'd with one another, have the proportion of one and an half with respect to their middle Distances from the Sun; that is, a proportion of a single proportion, and half as much more: Or, which comes to the same, the Squares of the Periodical Times are as the Cubes of the middle Distances, which it may be worth our while to illustrate by an Example:

The Middle Distance of the Earth from the Sun, to the Middle Distance of *Saturn*, is as an 100 to 951.

Hence it is inferr'd, that the Periodical Time of *Saturn* is 29 years and 327 days. For as the Cube of the Number 100 is to the Cube of the Number 951; So the Square of the Number 1, (that of the Earth's Revolution, or of one Tropical year,) is to the Square of the Number 29 years, 327 days; that is,

As 1000000 is to 860085351: So is 1 to 860.085351. For the Numbers 860.085351 is the Square Root of 29.327.

CHAP. XXI.

Of the Hypothesis *brought by the Learned* Seth Ward, D. D. *afterward Lord Bishop of* Salisbury, *and by* C. P.

Fig. XXXIV. IN Figure XXXIV. s is the Sun, plac'd in the lower *Focus* of the Elliptick; f is the upper *Focus* of the Elliptick; a the *Aphelium*, p the *Perihelium*, e the wandring Star or Planet; fe, or the Line parallel to it, sm, is the Line of the Middle Motion of the Planet; se is the Line of the true Motion of the Planet, (beheld from the Sun;) the Angle aft is the middle Anomaly, increasing equally in equal times; the Angle ase is the co-equall'd Anomaly; fet is a right Line, $et = es$.

'Tis now purpos'd to be shown, how from the Middle Anomaly, when given, or from the Angle aft, the co-equall'd Anomaly may be drawn, or the Angle ase.

The Demonstration.

Of the Triangle sfe the three sides $sf + fe + es = 2as$, according to the Nature of an Elliptick Figure.

Now $2as = as + af + fs$,
And by putting ps for af, is made
$2as = as + ps + fs$, β
Therefore by α, and β, and Ax. 1. $sf + fe + es = as + ps + fs$; And taking sf from both sides, there remains $fe + es = as + ps$;
And putting et for es, by way of supposition, there is made $fe + et$ (i. e. ft) $= as + ps$.
Again, $as - af = fs$.
And putting ps for af, there is made
$as - ps = fs$. δ
Now therefore in the Triangle sft there are given two sides, sf and ft, with the Angle comprehended in them, sft.
For $ft = as + ps$ by γ
And $fs = as - ps$ by δ
And aft is the Middle Anomaly, which Angle being external to the Angle sft, it is equal to the two internal and opposite Angles fts and fst, that is, the Angle aft is $Z<<$ of the unknown ones fts and fst.

Now by the *Trigonometrical* Rule:

Z II. X II $:: t\,\frac{1}{2}\,Z<< . \; t\,\frac{1}{2}\,X<<$, that is,
$ft + fs . ft - fs :: t\,\frac{1}{2}$ of the Angle $aft . \; t\,\frac{1}{2}\,X<< fts$ and fst,

That is by Interpretation,

$2as . 2ps :: t\,\frac{1}{2}$ of the Angle $aft . \; t\,\frac{1}{2}$ of the Angle fse ε:

For $ft = as + ps$ by γ
And $fs = as - ps$ by δ } Add first, and then subtract, and there is made
$Z = ft + fs = 2as$
$X = ft - fs = 2ps$, therefore
$\frac{1}{2}Z = as$, and
$\frac{1}{2}X = ps$.
Again, $X<< fst$ and $fts = fst - fts$,
And by putting est for fts is made
$X<< = fst - est = fse$,
Therefore $t\,\frac{1}{2}\,X<< = t\,\frac{1}{2}$ of the Angle fse, :
And therefore also $\frac{1}{2}\,Z$ II. $\frac{1}{2}\,X$ II. $:: t\,\frac{1}{2}\,Z<< . \; t\,\frac{1}{2}\,X<<$ That is, by ε.
$as . ps :: t\,\frac{1}{2}$ of the Angle $aft . \; t\,\frac{1}{2}$ of the Angle fse, which is a perpetual Rule for finding out the first Inequality of the Planets; and it is express'd in words thus: As is the *Aphelian* Distance of the Planet to the *Perihelian* Distance; so is the Tangent

Tangent of half the middle Anomaly, to the Tangent of half the co-equate Anomaly. And because the distance of the Planet, as well *Aphelian* as *Perihelian*, is constantly the same, 'tis plain, the two first Terms of the propos'd Analogy are always the same, to wit, in the Sun, for instance these:

The Logarithm of the Earth's greatest distance	4.00775
The Logarithm of the least distance	3.99216.

Whence by the Rule of Proportions; the second being divided by the first, or in Logarithms, the first being subtracted from the second, there remains a number, that is always to be added to the third; and that number which is to be added, will be always the same; because the two first Terms of the Analogy, by the Subtraction of which it arises, are always the same.

As for Example in the Sun, the first Term is	4.00775
Let it be subtracted from the second,	3.99216
And there always remains the number that is to be added to the third,	9.98441.

So for the rest of the Planets, the Numbers that are always to be added are these:

☉	998441
♄	995049
♃	995808
♂	991922
♀	999400
☿	981477
☾	996209

The use of this Table is this:

Add the Numbers always to the Artificial Tangent of half the middle Anomaly, the summ will be the Artificial Tangent of half the Co-equate Anomaly.

But farther, to find out the Line *s e*, or the distance of the Planet from the Sun, the Operation is to be thus wrought:

a f t, — *a s e*, = *s e f*, then

s of the Angle *s e f* . *s f* : : *s* of the Angle *a f t*, (*s f e*:) *s e*

But now, though this method do, from the middle Anomaly given, gather the Co-equate Anomaly directly, or *à Priori*; and though C. P. believ'd, that if there was any Variance in this *Hypothesis* from the *Hypotheses* of others, it was to be attributed to the errour of Astronomers, which is very great about the Octants from the *Aphelion* and *Perihelion*; yet 'tis certain, that this *Hypothesis* is almost as far wide from the Observations made in the Heavens, as he thought the Astronomers had err'd: Nor is that Disagreement from the Heaven only in some few Minutes, but so in *Mars* it may sometimes amount to almost half a degree, which no one can ever ascribe to the Faultiness of Observations.

Nor was *Kepler* ignorant, that this Inconvenience would follow the making an equable Motion about the upper *Focus*: For he said in his Epitome, that it might be *almost* so taken; but that *almost* was of such extent, that he thought it better to let it alone.

CHAP. XXII.

Of the Limitation, which Bullialdus *made to the foregoing* Hypothesis.

IN Figure XXXV, let *s* again be the Sun, plac'd in the lower *Focus*, *f* the upper *Focus*, *c* the Centre of the Elliptick *a q p*, and of the Circle that is drawn about it, *a* L *p*, *a* the *Aphelion*, *p* the *Perihelion*. Let the Line of the middle Motion be carried uniformly about the upper *Focus f*, as in the foregoing, and let it be *f e*, (or *f* E,) but with this difference, that whereas the Planet was before in the Line of the middle Motion, where it cuts the Elliptick Orbit, to wit, in *e*, (or E:) Now it is in the right Line *f m*, (or *f* M,) drawn from the upper *Focus f*, to the end *m*, (or M,) which the Ordinated Line *n m*, (or N M,) that is extended through *e*, (or E) the common Section of the Line of the middle Motion and of the Elliptick, does reach the Circle: For where this Right Line *f m*, (or *f* M,) cuts the Elliptick in ε, (or E,) there let the Centre of the Planet be suppos'd to be plac'd. Farther, from the Planet in ε, (or E,) to each *Focus* let there be drawn the right Lines ε *f*, ε *s*, (also E *f*, ε *s*,) and also from the same Point, let a Line be drawn parallel to the Line of the middle Motion, *viz.* ε *o*, parallel to *e f*, (and ε *o* to E *f*.) Figure XXXV.

The

The thing now propos'd, is from the middle Anomaly when given, or from the Angle *a f e*, to find the Co-equate Anomaly, or the Angle *f s t*: Therefore is first to be found the Angle *a f m*, which *Bullialdus* calls the middle true Anomaly. Now, as the least Semidiametre of the Elliptick *c q*, is to the greatest *c* L; so is *n e* to *n m*; so also is the Tangent of the middle Anomaly *a f e*, to the Tangent of the middle true Anomaly *a f m*.

And now the Angle *a f m*, or *a f t* being found, which is External to the Triangle *f s t*, *f s t* is found by the same Analogy, as in the foregoing Chapter, by saying; *a s* . *p s* : : *t* $\frac{1}{2}$ of the Angle *a f e* . *t* $\frac{1}{2}$ of the Angle *f s t*.

The found Angle *f s t* is taken from *a f t*, and there remains *f t s*. Then, as the Sign *f t s* to *f s*; so is the Sign *a f t*, (or *t f s*,) to *s t* the distance of the Planet from the Sun.

Now the difference of the middle Anomaly *a f e*, or *a o t*, and of the co-equate *f s t*, is *s t o*, and is call'd the *Prosthaphæresis*. And now by this Limitation, *Bullialdus* has brought it to pass, that from the middle Anomaly might be gather'd the co-equate *à Priori*; and also that at the same time the Computation should answer the Observation, which in the Elliptical *Hypothesis* no one ever did before him.

CHAP. XXIII.

Of finding the Geocentrick place of the Planet.

HAving been hitherto in explaining the first Inequality of the Planets, I come now to the second: For by what goes before, is found the place of the Planet, as it would be seen from the Sun, if our Eye was there plac'd, and is call'd for that reason, the Heliocentrick place of the Sun. But now seeing the Stars or Planets that are wheel'd about the Sun, do appear to us on Earth in another place from what they would, if look'd upon from the Sun; there happens to the Planets a second Inequality, not that there is really any such thing in their notions; but because the yearly Motion of the Earth (*i e*,) the Motion of our Eye seems to be in them: Wherefore this second Inequality is properly call'd the *Parallaxis* of the Orb, (understand it of the Earth's yearly Orb,) because it solely depends upon the moving of the Eye, from the Centre of the universe, (the Sun) and the place of the Planet that is seen from the Earth, is call'd the Geocentrick place; and it seems to be an useful distinction between the Line of the true, and the Line of the apparent Motion; that the former is drawn from the Centre of the Sun, through the Centre of the Planet, but that the latter is drawn from the Centre of the Earth, through the Centre of the Planet too; yet that each of them is continued to the very Firmament. The Reason of the name may be, because the place that is seen from the Sun is come to, by the true and proper Motion of the Planet; but that which is seen from the Earth, is owing to no other than an apparent seeming Motion. But now before the Geocentrick place of the Planet can be found, we must first bring its Heliocentrick place in the Orbit to the Ecliptick, which is done by the help of a Spherical Triangle, that lies between the Node and the Planet in the Orbit, and the Point, which the Circle of Inclination, drawn through the Planet, does find in the Ecliptick: For the difference between the *Hypoteneuse*, or the subtended side of this Triangle, and the greater Leg or side, is the very Reduction to the Ecliptick; and the lesser Leg of the same Triangle is call'd the Inclination. Then the distance of the Planet from the Sun is to be abbridged, which is done by the help of a certain Plane Rectangular Triangle, that lies between the Sun, that is plac'd in the Centre of the Sphere, and the Planet in its Orbit, and the Point, which a Right Line, falling perpendicularly from the Planet upon the Plane of the Ecliptick, does at length reach to: For the greater Leg of this Triangle, (to wit, the Line that is drawn in the Plane of the Ecliptick, from the Sun to the very Point, which it finds when it falls perpendicular,) is the very abbridged distance of the Planet.

Now therefore to find out the Geocentrick Place of the Planet, we ought to have ready, 1. The true Place of the Sun. 2. The Heliocentrick Place of the Planet. 3. The Distance of the Earth from the Sun. 4. The Abbridged Distance of the Planet from the Sun. And being furnish'd with these, we conceive a rectilinear Triangle in the Plane of the Ecliptick, between the Sun, the Earth, and the Heliocentrick Place of the Planet in the Ecliptick. As for Instance, in Figure XXXVI. let S be the Sun, T the Earth, E the wandring Star or Planet. And let there be given, First, The true Place of the Sun seen from the Earth in the Line T S V in 12° ♍. Secondly, The Heliocentrick Place of the Planet in the Ecliptick, seen from the Sun in the Line S E H in 22° ♉. Thirdly, The Distance of the Earth from the Sun S T, in Log. let it be 3.99255. Fourthly, The Abbridged Distance of *Jupiter* from the Sun S E, in Log. 4.72821. 'Tis now propos'd to us, from these things given to find out the Geocentrick Place of the Planet, that is seen from the Earth in the Line T E G.

1. From the true Place of the Sun	5s	12°
Take away the Heliocentrick Place of the Planet	1	22
There remains the Angle to the Sun V S H	3	20

Now therefore in the Triangle S T E there being given the two sides S T and S E, with the external Angle V S H, which is equal to the Summ < < of the unknown ones S T E and S E T; the Angle S T E is thence sought for, which is call'd the Angle to the Earth, lying between the Line of the true Motion of the Sun T S V, and the Line of the Apparent Motion of the Planet, T E G.

The working of it is thus:

S E 4.72821 }
S T 3.99255 } Subtract.

Prefixt to the remainder 1, there is made 10.73566, which is the Artificial Tangent 79° 35', whence there being 40° taken away, there remains 34° 35'. The Artif. Tang. of which is 9.83850. Then the half of the Ang. V S H 55 00
The Tangent is 10.15477
The Summ, the Root being deducted, is 19.99327 The Tangent of the Arch 44 33

The Summ of the Arches 99 33
is the greater unknown Angle S T E, which is call'd the Angle to the Earth. Therefore the Apparent Place of *Jupiter* is on this side the true Place of the Sun in the Angle S T E, or degrees 99° 33'.

For take from the true place of the Sun	5s	12°	00'
the Angle to the Earth	3	09	33
And there remains the Geocentrick place of ♃	2	02	27.

Lastly, to find the Latitude of the Planet, or it's distance from the Ecliptick, as it is seen from the Earth, say,

As the Sine of the Angle to the Sun
is to the Sign of the Angle to the Earth,
So is the Arch of Inclination (computed in degrees and minutes)
to the Arch of Latitude.

And having been hitherto in laying down and explaining the *Hypothesis* of others, I have a mind to subjoyn one of my own, which I began to frame about twenty four years ago, And I did some time ago cast it into the form of a little Book, which is to be now inserted.

SECTION III.

A New Astronomical Hypothesis, *and its Agreement with Observations.*

The Contents of the BOOK.

The Chapters of this Book are three:

The First lays down the New *Hypothesis*.
The Second teaches how to calculate according to it.
The Third compares the Calculations with the Observations.

CHAP. I.

Laying down the Hypothesis.

1. I Suppose the Motion of the Earth about it's own Axle to be equable, that is, that the Revolution of every *Meridian* to any fixt Star is always perform'd in equal Spaces of time, let the Earth be in what Place of its Orbit it will. Which Supposition, though it be not new; yet since several have thought otherwise, and yet nevertheless the Daily Revolution, together with the Difference of the True and middle yearly Motion, does constitute one Element or Principle of the Equation of Time, (for the Difference of Longitude, and of the Right Ascension of the Earth is another Thing;) therefore it was to be declar'd, what it is, that I judg'd fit to be follow'd here.

2. I shall now use no other Procession of the *Æquinoxes*, than what *Kepler* did, *viz.* 51″ for every year; that without any troublesome Reduction I may give you, as near as I can, the Observations deliver'd by him in his Commentary concerning the Planet *Mars*, which are affected by a Procession of the *Æquinoxes* as great as has been said; yet I am not at the same time ignorant, that possibly the Motion of the *Æquinoxes* may be something otherwise.

3. Again, let us suppose the *Aphelia* and the Nodes of the Planets to have perpetually the same Place under the fixt Stars, or, which comes to the same, not to be mov'd by any other Motion, than that of the Procession of the *Æquinoxes*.

Scheme XXXVII. 4. In Scheme XXXVII. let S be the Sun, *f* the Superior *Focus*, *c* the Centre of the Elliptick, *m* the Point of the divided Section, namely, in which the Distance of the *Focusses* *s f* is cut according to its extreme and middle Proportion; And let the same be also the Centre of a Circle made by the Ray *m d*, which is equal to *c a* or *c p*, the Semidiametre of the greatest Elliptick. Let *a* be the *Aphelion*, *p* the *Perihelion*, *a f d* the Middle Anomaly, *a s d* the co-equate Anomaly, *f d s* the *Prosthaphæresis*, *e* the Planet, *s e* the Distance of the Planet from the Sun.

5. The

5. The Determination of the Lines.

	In the *Sun.*	In *Mars.*
c a, or *m d*	10000000	15236900
s f	344477	2835800
s m	212898	1752621
m f	131578	1083179

CHAP. II.

Teaching how to Calculate according to the Hypothesis *now laid down.*

TO the Calculation belong these; *1st.* The Equation of Time. 2. The Computation of the Middle Motions. 3. The Equation of the Centre. 4. The Parallax of the Orb. Every one of them will be made the more ready and easie by the Tables that are added at the End. Of which the first does present you with the perpetual Equation of Time in two Parts. The second contains the Middle Motions of the Sun and of *Mars*, and also their *Epochæ*. Thirdly, Then follow three *Laterculi*, with the Numbers written upon them that are constantly requisite for the finding out of the Equation of the Centre, and of the Distance of the Earth and of *Mars* from the Sun Lastly, I have transcrib'd out of the *Rudolphine* Tables *Morinus's* Tables of the Inclinations of *Mars*, to wit, for shortening the Distance, and of his Reduction to the Ecliptick.

1. The Equation of Time consists of two parts, The first is taken from the former part of the Table that is to be gone to with the true place of the Sun. And the little Particles that are taken away are added to the Apparent Time, (of which kind is that of the Observations,) or subtracted according to the Titles express'd in the Table, that the Time may first of all become equall'd. But the latter part of Equation may be then found out, when to the Time first equall'd you have computed the Middle Anomaly of the Sun out of the Tables of middle Motions: For with that middle Anomaly out of the latter Table of the Equation of Time, you may take the Minutes and Seconds that are to be applied to the Time first equall'd, (as the Titles written upon them do teach,) that there may be had the truly Astronomical or middle Time. And to or from the same Minutes and Seconds add or take away a competent Portion of the Motion of the Sun, according as the same Tables direct to the Middle Motion, as well of Longitude as of the Anomaly of the Sun before found.

2. Now the middle Motions are by Computation brought to Astronomical, Time out of the Second Table, by a common way known to all ; so that I need say nothing of that.

3. The Equation of the Centre, from the middle Anomaly given *a f d*, makes the true *a s d*, and the very *Prosthaphæresis* too, *f d s*, consisting of two parts, *f d m*, and *m d s*. The first part is found in the Triangle *f d m*, whose sides *f m* and *m d* being given, they are of a constant length with *a f d*, the external Angle of the middle Anomaly, that is given ; wherefore M *d* . M *f* : : to the Sign *a f d* : to the Sign *f d m*. For the Log. *m d* being subtracted from the Log. *m f*, there remains the constant Logarithmical Number, noted in the first *Laterculus* by the Letter A, and is always to be added to the Sign of the middle Anomaly that is given, *a f d*, that there may be made the Sign *f d m*. The latter part of the Equation of the Centre is found in the Triangle *m d s*, whose sides *m d* and *m s* being given, they are of a constant Length with the External Angle *f m d* = *a f d* — *f d m* ; wherefore *m d* + *m s* . *m d* — *m s* : : to the Tang. ½ *f m d*. Tang. ½ X <<. For the Log. *m d* + *m s* being subtracted from the Log. *m d* — *m s*, there remains the constant Logarithmical Number, noted

in the first *Laterculus* by the Letter B, and is always to be added to the Tangent $\frac{1}{2}$ *f m d*, That it may be made the Tang. $\frac{1}{2}$ X < <, &c.

4. The Parallax of the Orb requires the Distance of the Earth and of the Planet from the Sun, which I shall teach you to find two ways; to wit, by using the first way the Numbers of the second *Laterculus*; but the latter way the Numbers of the Third. The first way I use mere Artificial Figures: For to half of the Sign of the Complement of the Angle *a s d* I always add the Logarithmical Number of the Second *Laterculus*, noted by the Letter C. I enquire for the Summ between the Signs, when the Angle *a s d* is acute, or between the Tangents, when *a s d* is obtuse; and I double the Sign of the Complement that answers to that Sign or this Tangent; and when doubled I take it from the Number of the Second *Laterculus*, that is noted by the Letter D, if *a s d* be acute; or I add it, if it be obtuse, (borrowing there, and casting away here the doubled Ray;) so there comes from thence the Logarithm of the Distance of the Planet from the Sun. In the latter way I use partly natural Numbers, and partly Artificial As to the Natural 'tis to be observ'd, that I take the Ray = 1. Now to the Number of the third *Laterculus* noted with the Letter E, (which is natural,) I take away also the natural Sign of the Complement of the Angle *a s d*, when it is acute, or I add it, when that is obtuse; and the Logarithm of the Remainder or Aggregate I always subtract from the Number of the Third *Laterculus*, mark'd by the Letter F; and what remains is also the Logarithm of Distance of the Planet from the Sun, to wit: $\frac{ap}{fs}$ the Sign of Complement of

$$asd . \overline{2fs}^{\text{Root}} :: ap2 - fs2 . se.$$

The first way may be us'd, when only the Artificial Canon of Triangles is at hand: The later requires both the Natural Canon and the Logarithms of absolute Numbers, And it is something more easie, than the former. Moreover, to the middle Anomaly of *Mars* I always add three Signs, 12°, that there may be the Argument of Latitude, with which I take away the Inclination to shorten the Distance that's already found, as also the Reduction to the Eclíptick. This only I add, That when the Planet draws nigh to it's Acronychial Position, I then seek the Angle to the Earth by this Analogy:

As the Distance of the Planet from the Earth
is to the Distance of the same from the Sun,
So the Angle to the Sun
is to the Angle to the Earth,

which I add to, or subtract from ☍ of the true place of the Sun, according as the Planet is on this side or beyond ☍. Now the Distance of the Planet from the Earth in it's Acronychial Position, or thereabouts, is the Difference of the Distances of the Planet and of the Earth from the Sun, or much thereabouts.

Example.

In the Year 1580. *Novemb.* 18. h. 1. 31′, *Mars* was observ'd by *Tycho* at *Vrenburgh*, to be near his Acronychial Position in ♊ 6°, 28′, 35″. The Sun being in ♐ 6$\frac{1}{4}$. There the first Equation of Time is 7′, 29″ subtracted. From whence we have the Time first equall'd hor. 1. 23′ 31″, to which I take out of the second Table the Middle Motions of the Sun and of his Apogée after this manner.

	Sun from the *Æquinoctial.*				*Sun*'s Apogée.			
	Si.	De.	Min.	Sec.	Si.	De.	Min.	Sec.
1560	09	20	35	19	03	05	23	00
19	11	29	25	10	00	00	16	09
October compleat	09	29	38	15	00	00	00	43
Day 18	00	17	44	31	00	00	00	03
Hour 1	00	00	02	28	00	00	00	00
Min. 23	00	00	00	57	00	00	00	00
Sec. 31	00	00	00	01	00	00	00	00
Sun's mean Motion	08	07	26	41	03	05	39	55
Sun's Apogée	03	05	39	55				
Sun's mean Anomaly	05	01	46	46				

With

With the middle Anomaly of the Sun 5^s, 1°, 46′, 46″, I take away the latter part of the Equation of Time 3′, 49″, by subtraction; wherefore the Time truly Astronomical is h. 1, 19′, 42″; And a Portion of the Motion of the Sun, agreeing with the latter part of the Equation of Time, *viz.* 9″ being subtracted from the middle Motion of the Sun, leaves it 8^s, 7°, 26′, 32″; but being subtracted too from the middle Anomaly, it leaves 5^s, 1°, 46′, 37″, or 151°, 78′, omitting the lesser and more minute Particles, which are above an hundred parts of a Degree. For the Calculation will be much the easier by losing now and then one or two first minutes; And yet it will come nearer the Observations, than the most accurate Calculation that has been yet found.

To the Artificial Sign 9.67473 does answer the middle Anomaly that is given —— 151.78 } Subt.

Add always A 8.11918

The Sum. is the Art. Si. 17.79391 of the Angle *f m d* —— 0.36 α

There remains *f m d* —— 151.42

Whose half is ½ Z << 75.71 } Subt.

of which the Artificial Tangent is 10.59395

Add always B —— 9.98151

The Summ is the Tangent 10.57546, to which answ. ½ X << 75.12

There remains the Angle *m d t* 0.59 β

$\alpha + \beta$ is the *Prosthaphæresis f d s* 0.95 Subt.

or 57′, 0″, Subt.

	Si.	Deg.	Min.	Sec.	
Therefore now from the middle Motion of the Sun	08	07	26	32	
take the *Prosthaphæresis*	00	00	57	00	Subt.
There rests the true place of the Sun ——	08	06	27	32	

Farther, from the middle Anomaly given *a f d* 151.78

take always the *Prosthaphæresis f d s* 0.95

there remains the co-equate Anomaly *a s d* 150.83

Of this Sign of Complement the half is —— 4.97055

Add always C 4.11807

The Summ (because *a s d* is obtuse) is the Tangent 9.08862

to which answers the Sign of Complement doubled, 19.99352

the which (*a s d* being obtuse) I add to D, 4.99987

The Summ (the doubled Ray being cast away) is the Distance of the Earth from the Sun. 24.99339

Again, at the time truly Astronomical above found, *viz.* 1580. *Novemb.* 18, h. 1, 19′, 42″, let the middle Anomaly of *Mars* be sought.

	Mars from the Equin.				*Aphelion* of *Mars.*			
	Si.	De.	Min.	Sec.	Si.	De.	Min.	Sec.
1560	07	00	32	13	04	28	12	04
19	01	06	32	45	00	00	16	09
October compleat	05	09	19	07	00	00	00	43
Day 18	00	09	26	00	00	00	00	03
Hour 1	00	00	01	19	00	00	00	00
Min. 19	00	00	00	25	00	00	00	00
Sec. 42	00	00	00	01	00	00	00	00
Mean Motion of *Mars*	01	25	51	50	04	28	28	59
Aphelion of *Mars*	04	28	28	59				
Mean Anomaly of *Mars*	08	27	22	51				

Therefore to the middle Anomaly 8s, 270, 22′, 51″, or it's Complement to the whole Circle 3s, 2°, 37′, 9″, that is, 92.62. I seek the *Prosthaphæresis.*

To the Artificial Sign	9.99955 answering the middle Anom. given	92.62	Subt.
Add always A	8.85180		
The Summ is the Sign Art. 18.85135 of the Angle *f d m*		4.07	α
There rests *f m d*		88.55	
whose half is ½ Z<<		44.27	Subt.
whose Artificial Tangent is	9.98893		
Add always B	9.89965		
The Summ is the Artif. Tan.	19.88858 to which answer ½ X<<	37.73	
There remains the Angle *m d s*		6.54	β
α + β is the *Prosthaphæresis f d s*		10.61	Add
Or 10°, 36′, 36″, A.			

	Si.	De.	Min.	Se.	
Now therefore to the middle Motion of *Mars*	01	25	51	50	
Add the *Prosthaphæresis*	00	10	36	36	A
The Summ is the place of the Eccentricity of ♂ in the Orbit,	02	06	28	26	

	Si.	De.	Min.	Se.	
To the middle Anomaly of *Mars* given,	08	27	22	51	
Add always	03	12	00	00	
There is made the Argument of Latitude	00	09	22	51	
to which answers the Inclination, or there abouts,	00	00	18	00	
that is 0.30 to be kept; and the Reduction	00	00	00	17	Subt.
Now therefore from the place of Eccent. of *Mars* in the Orbit	02	06	28	26	
take away the Reduction	00	00	00	17	S
There remains the place of Eccent. of *Mars* in the Ecliptick	02	06	28	09	

But farther, from the middle Anom. given *a f d*	92.62	
take always the *Prosthaphæresis f d s*	10.61	
there remains	82.01	
Of this Sign of Complement the half is	4.57151	
Add always C	4.48442	
The Summ (because *a s d* is acute) is the Sign	9.05593	
to which answers the doubled Sign of Complement	19.99435	Subt.
which I subt. (*a s d* being acute) from D, the doubled Ray increas'd,	25.17912	
There remains the Distance of *Mars* from the Sun	5.18477	γ

The same Distance of *Mars* from the Sun is found also the latter way, Thus:

To the Co-equate Anomaly *a s d*	82.01
answers the Natural Sign of Complement	15900
to be subtracted (when *a s d* is acute) from E	10.74610
There remains	10.60710
whose Logarithm is	1.02559
to be always taken from F	6.21037
There remains the Distance of *Mars* from the Sun	5.18477

The same that was above at γ.

The

The Inclinations of *Mars* reserv'd above 0°.30 the Sign of Complement is	999999
whose Difference from the Ray is	1
which is abbreviation, whereby the Distance of *Mars* becomes shorten'd	5.18476

	Si. De. Min. Se.
The true place of the Sun above found was	08 06 29 32
The Eccentrick place of *Mars* in the Ecliptick	02 06 28 09
The Arch that *Mars* is distant from ☍ ☉, or the Angle to ☉ is	00 00 01 23

The Distance of *Mars* from the Sun 5.18476, answered by the absolute Number	153023	Subt.
Also the Distance of the Earth from the Sun 4.99339, answered by the absolute	98489	
The Difference is the Distance of the Earth from *Mars*	54534	

As therefore the Distance of the Earth from *Mars*	4.73667
to the Distance of the Sun from *Mars*	5.18476
So the Angle to the Sun (*viz.* the Logarithm 83″)	1.91908
to the Angle to the Earth	2.36717

Whose absolute is 3′, 53″, which *Mars* from on Earth seems to be distant from ☍ of the Sun.

	Si. De. Min. Se.
Therefore from ☍ of the Sun	02 06 29 32
(because *Mars* is on this side the ☍ ☉) take	05 00 03 53
There remains the true Place of *Mars* computed,	02 06 25 39
But the Place of *Mars* observed was	02 06 28 35
The Difference is	00 00 02 56+

CHAP. III.

Comparing the Calculation with Observations.

According to the Method laid down in the former Chapter, I have computed fourteen Acronychial Observations, and twenty eight out of his Acronychial Position, the Product of which Calculation take as follows:

Fourteen

Fourteen of the Extream Fulsions, or of the brightest shinings of Mars, *of which the twelve first are out of* Kepler's *Commentary concerning* Mars, *the two last are taken out of* Longomotanus's *two Books of Theoricks, and either taken or reduc'd to the Meridian of* Urenburgh.

					The *Sun's* true Place.				The mean Anomaly of *Mars*.				The Place of *Mars* by Computation.				The Place of *Mars* by Observation.				Difference	
Years.	Months	Da.	Ho.	Mi.	S.	D.	M.	S.	S.	D.	M.	S.	S.	D.	M.	S.	S.	D.	M.	S.	M.	S.
1580	Novem.	18	01	31	♐	06	29	32	08	27	22	51	♊	06	25	39	♊	06	28	35	02	56+
1582	Decem.	28	03	58	♑	16	53	05	10	10	56	52	♋	16	56	24	♋	16	55	30	00	54−
1585	January.	30	19	14	♒	21	34	23	11	21	38	48	♌	21	35	29	♌	21	36	10	00	41+
1587	March.	06	07	23	♓	25	38	14	01	02	16	19	♍	25	46	03	♍	25	43	00	03	03−
1589	April.	14	06	23	♉	04	20	41	02	15	45	09	♏	04	27	29	♏	04	23	00	04	29−
1591	June.	08	07	43	♊	26	42	22	04	07	09	00	♐	26	40	41	♐	26	43	00	02	19+
1593	August.	25	17	27	♍	12	21	52	06	11	18	21	♓	12	16	37	♓	12	16	00	00	37−
1595	October.	31	00	39	♏	17	35	15	08	08	35	23	♉	17	30	10	♉	17	31	40	01	30+
1597	Decem.	13	15	54	♑	02	28	02	09	24	31	52	♋	02	24	04	♋	02	28	00	03	56+
1600	January.	18	14	02	♒	08	34	39	11	05	54	22	♌	08	35	41	♌	08	38	00	02	19+
1602	Febru.	20	14	13	♓	12	21	33	00	16	16	19	♍	12	24	24	♍	12	27	00	02	36+
1604	March.	28	16	23	♈	18	33	50	01	28	14	59	♎	18	33	42	♎	18	37	10	03	28+
1608	July.	24	02	00	♌	11	14	10	05	15	23	18	♒	11	13	18	♒	11	11	00	02	18−
1610	October.	08	16	50	♎	25	33	51	07	18	04	34	♈	25	28	14	♈	25	31	00	02	46+

As to the two last it is to be noted, that Longomontanus *delivers the last but one to be* ♒ 11°, 10′, 00″, *and the last to be* ♈ 25°, 30′, 00″. *But his Procession of the* Æquinox *is less than* Kepler's *by* 1′, *which Minute I have therefore restor'd.*

The Places of *Mars* out of his Acronychial Position, observed at *Urenburgh*, and recorded by *Kepler* in his Commentary of *Mars*.

					Suns true place.				Mean Anomaly ♂				Place ♂ by Com.				Place ♂ by Ob.				Difference	
Years.	Months.	Da.	Ho.	Mi.	S.	D.	M.	Se.	S.	D.	M.	Se.	S.	D.	M.	Se.	S.	D.	M.	Se.	M.	Se.
1582	Novem.	23	16	00	♐	11	41	25	09	22	51	48	♋	26	40	13	♋	26	38	30	01	43—
	Decem.	26	08	30	♑	15	02	20	10	09	59	54	♋	17	38	57	♋	17	40	30	01	33+
	Decem.	30	08	10	♑	19	05	59	10	12	05	17	♋	16	03	15	♋	16	00	30	02	45—
1583	Janu.	26	06	15	♒	16	28	04	10	26	11	50	♋	08	22	40	♋	08	20	30	02	10—
1584	Decem.	21	14	00	♑	10	41	41	11	00	34	01	♍	01	15	17	♍	01	13	30	01	47—
1585	Janu.	24	09	00	♒	15	04	43	11	18	16	44	♌	24	09	43	♌	24	07	30	02	13—
	Febru.	04	06	40	♒	26	05	42	11	23	59	31	♌	19	47	30	♌	19	47	00	00	30—
	March.	12	10	30	♈	02	11	25	00	12	56	17	♌	11	45	37	♌	11	46	00	00	23+
1587	Janu.	25	17	00	♒	15	56	13	00	11	31	22	♎	04	42	25	♎	04	42	00	00	25—
	March.	04	13	24	♓	23	54	00	01	01	21	19	♍	26	26	03	♍	26	25	40	00	23—
1587	March.	10	11	30	♓	29	46	28	01	04	27	27	♍	24	05	56	♍	24	05	15	00	41—
	April.	21	09	30	♉	10	45	09	01	26	25	09	♍	15	51	45	♍	15	48	20	03	25—
1589	March.	08	16	24	♓	28	30	17	01	26	35	10	♏	12	15	17	♏	12	16	50	01	33+
	April.	13	11	15	♉	03	34	45	02	15	20	06	♏	04	43	11	♏	04	43	20	00	09+
	April.	15	12	05	♉	05	33	17	02	16	24	04	♏	03	59	04	♏	03	58	20	00	44—
1589	May.	06	11	20	♉	25	46	15	02	27	23	19	♎	27	10	15	♎	27	07	20	02	55—
1591	May.	13	14	00	♊	02	08	03	03	23	39	39	♑	02	18	51	♑	02	20	00	01	09+
	June.	06	12	20	♊	24	59	38	04	06	12	09	♐	27	11	45	♐	27	15	00	03	15+
	June.	10	11	50	♊	28	47	11	04	08	17	17	♐	25	58	40	♐	26	02	36	03	56+
	June.	28	10	24	♋	15	51	44	04	17	41	26	♐	21	07	20	♐	21	10	00	02	40+
1593	July.	21	14	00	♌	08	28	13	05	22	53	30	♓	17	45	01	♓	17	45	45	00	44+
	August.	22	12	20	♍	09	14	54	06	09	37	21	♓	13	08	26	♓	13	10	15	01	49+
	August.	29	10	20	♍	15	57	52	06	13	14	44	♓	11	15	05	♓	11	14	00	01	05—
	October.	03	08	00	♎	20	19	42	07	01	31	55	♓	07	46	06	♉	07	50	10	04	04+
1595	Septem.	17	16	45	♎	04	22	26	07	15	53	09	♉	26	08	38	♉	26	07	12	01	25—
1595	October.	27	12	20	♏	14	02	39	08	06	44	54	♉	18	47	40	♉	18	51	15	03	26+
	Novem.	03	12	00	♏	21	05	17	08	10	24	36	♉	16	16	28	♉	16	18	30	02	02+
	Decem.	18	08	00	♑	06	42	10	09	03	54	36	♉	11	40	22	♉	11	40	00	00	22—

The

The Close.

'TIS *plain therefore from what goes before, that our* Hypothesis *does give the Equations of the Centre* à Priori, *not only as accurately and as easily, but even more accurately and more easily than any* Hypothesis *that has been yet invented. And let no one object, that in Calculation I neglect the more minute Particles; for any one may take notice of them, if he please; and yet the Calculation will not be so full of trouble as any other, but rather the very great variance of Calculation will be something diminish'd; for it will never run out to the four first Minutes.*

TABLE I.

TABLE I.

Shewing the Equation of Time in two parts.

Subtract from the Apparent

The true place of the Sun.

Degrees.	S. ♈ ♎ Min. sec.	♉ ♏ Min sec.	♊ ♐ Min. sec.	Degrees.
0	00 00	08 25	08 47	30
1	00 20	08 36	08 37	29
2	00 40	08 45	08 26	28
3	00 59	08 55	08 15	27
4	01 19	09 04	08 03	26
5	01 39	09 12	07 50	25
6	01 59	09 19	07 36	24
7	02 18	09 25	07 22	23
8	02 38	09 32	07 07	22
9	02 57	09 37	06 52	21
10	03 16	09 42	06 36	20
11	03 35	09 46	06 20	19
12	03 53	09 50	06 03	18
13	04 12	09 52	05 46	17
14	04 30	09 54	05 28	16
15	04 47	09 56	05 10	15
16	05 05	09 56	04 51	14
17	05 22	09 56	04 32	13
18	05 38	09 55	04 12	12
19	05 55	09 53	03 53	11
20	06 11	09 51	03 33	10
21	06 26	09 48	03 12	9
22	06 41	09 44	02 51	8
23	06 56	09 40	02 31	7
24	07 10	09 34	02 09	6
25	07 24	09 28	01 48	5
26	07 37	09 21	01 27	4
27	07 50	09 14	01 05	3
28	08 02	09 06	00 43	2
29	08 14	08 57	00 22	1
30	08 25	08 47	00 00	0
	S. ♓ ♍	♒ ♌	♑ ♋	

The middle Anomaly of the Sun.

Degrees.	Sign. 0. Min. sec.	1 Min. sec.	2 Min. sec.	3 Min. sec.	4 Min. sec.	5 Min. sec.	Degrees.
0	00 00	03 54	06 48	07 56	06 57	04 03	30
1	00 08	04 01	06 52	07 56	06 53	03 55	29
2	00 16	04 08	06 56	07 56	06 49	03 48	28
3	00 24	04 15	07 00	07 56	06 44	03 40	27
4	00 33	04 22	07 04	07 56	06 40	03 33	26
5	00 41	04 28	07 08	07 55	06 35	03 25	25
6	00 49	04 35	07 11	07 55	06 30	03 18	24
7	00 57	04 42	07 15	07 54	06 25	03 10	23
8	01 05	04 48	07 18	07 53	06 20	03 02	22
9	01 13	04 55	07 21	07 52	06 15	02 54	21
10	01 21	05 01	07 24	07 51	06 10	02 46	20
11	01 29	05 07	07 27	07 49	06 05	02 38	19
12	01 37	05 14	07 30	07 48	05 59	02 30	18
13	01 45	05 20	07 33	07 46	05 54	02 22	17
14	01 53	05 26	07 35	07 45	05 48	02 14	16
15	02 01	05 32	07 37	07 43	05 42	02 06	15
16	02 09	05 38	07 40	07 41	05 36	01 58	14
17	02 16	05 43	07 42	07 38	05 30	01 49	13
18	02 24	05 49	07 44	07 36	05 24	01 41	12
19	02 32	05 54	07 46	07 34	05 18	01 33	11
20	02 40	06 00	07 47	07 31	05 11	01 25	10
21	02 47	06 05	07 49	07 28	05 05	01 16	9
22	02 55	06 10	07 50	07 25	04 58	01 08	8
23	03 02	06 15	07 51	07 22	04 52	00 59	7
24	03 10	06 20	07 53	07 19	04 45	00 51	6
25	03 17	06 25	07 54	07 16	04 38	00 42	5
26	03 25	06 30	07 54	07 12	04 31	00 34	4
27	03 32	06 35	07 55	07 09	04 24	00 25	3
28	03 39	06 39	07 56	07 05	04 17	00 17	2
29	03 47	06 44	07 56	07 01	04 10	00 08	1
30	03 54	06 48	07 56	06 57	04 03	00 00	0
	Sig. 11	10	9	8	7	6	

Add to the Apparent

TABLE. II.

Shewing the middle Motions of the Sun *and* Mars.

The *Epocha* of the middle motions of the *Sun* and *Mars*, for the Meridian of *Urenburgh*, in the Kalends of *January*, the Mid-day of Astronomical Time, according to the *Julian* Account.

Years of Christ compl.	Sun *from the* Æquinox.				Sun's *Apogée.*				Mars *from the* Æquinox.				Aphelion *of* Mars.			
	Sig.	gr.	min.	sec.	Sig.	gr.	min.	sec.	Sig.	gr.	min.	sec.	Sig.	gr.	min.	sec.
1560	09	20	35	19	03	05	23	00	07	00	32	13	04	28	12	04
1580	09	20	45	20	03	05	40	00	02	18	53	37	04	28	29	04
1600	09	20	55	21	03	05	57	00	10	07	15	01	04	28	46	04

Years expanded.	Sun *from the* Æquinox.				Mars *from the* Æquin.				*Procession of the* Æquin.			
	Sig.	grad.	min.	sec.	Sig.	grad.	min.	sec.	Sig.	grad.	min.	sec.
1	11	29	45	43	06	11	17	13	00	00	00	51
2	11	29	31	26	00	22	34	25	00	00	01	42
3	11	29	17	09	07	03	51	38	00	00	02	33
4	00	00	02	00	01	15	40	17	00	00	03	24
5	11	29	47	43	07	26	57	29	00	00	04	15
6	11	29	33	26	02	08	14	42	00	00	05	06
7	11	29	19	09	08	19	31	55	00	00	05	57
8	00	00	04	00	03	01	20	34	00	00	06	48
9	11	29	49	43	09	12	37	46	00	00	07	39
10	11	29	35	26	03	23	54	59	00	00	08	30
11	11	29	21	09	10	05	12	11	00	00	09	21
12	00	00	06	01	04	17	00	50	00	00	10	12
13	11	29	51	44	10	28	18	03	00	00	11	03
14	11	29	37	27	05	09	35	16	00	00	11	54
15	11	29	23	10	11	20	52	28	00	00	12	45
16	00	00	08	01	06	02	41	07	00	00	13	36
17	11	29	53	44	00	13	58	20	00	00	14	27
18	11	29	39	27	06	25	15	32	00	00	15	18
19	11	29	25	10	01	06	32	45	00	00	16	09
20	00	00	10	01	07	18	21	24	00	00	17	00

Months completed.	Sun *from the* Æquin.				Mars *from the* Æquin.				*Procession of the* Æquin.			
	Sig.	grad.	min.	sec.	Sig.	grad.	min.	sec.	Sig.	grad.	min.	sec.
January	01	00	33	19	00	16	14	47	00	00	00	05
February	01	28	09	13	01	00	55	14	00	00	00	09
March	02	28	42	31	01	17	10	00	00	00	00	13
April	03	28	16	41	02	02	53	20	00	00	00	17
May	04	28	49	59	02	19	08	06	00	00	00	21
June	05	28	24	09	03	04	51	26	00	00	00	25
July	06	28	57	28	04	21	06	13	00	00	00	30
August	07	29	30	46	04	07	21	00	00	00	00	34
September	08	29	04	56	04	23	04	19	00	00	00	38
October	09	29	38	15	05	09	19	07	00	00	00	43
November	10	29	12	25	05	25	02	26	00	00	00	47
December	11	29	45	43	06	11	17	13	00	00	00	51

The Residue of TABLE II.

Shewing the middle Motions of the Sun *and* Mars.

Days.	☉ *from* Æqu.	♂ *from* Æq.	Æqu. Pr.	Hours and Minutes. ☉ *from* Æ.	♂ *from* Æ.	Minutes.	☉ *from* Æq.	♂ *from* Æq
	Deg. min. sec.	Deg. min. sec.		Deg. mi. sec.	Min. sec.		M. se. ‴.	M. se. ‴.
1	00 59 08	00 31 27	00	0 02 28	01 19	31	1 16 23	0 40 37
2	01 58 16	01 02 53	00	0 04 56	02 37	32	1 18 51	0 41 55
3	02 57 25	01 34 20	00	0 07 24	03 56	33	1 21 19	0 43 14
4	03 56 34	02 05 47	01	0 09 51	05 14	34	1 23 47	0 44 33
5	04 55 42	02 37 14	01	0 12 19	06 33	35	1 26 14	0 45 51
6	05 54 50	03 08 40	01	0 14 47	07 52	36	1 28 42	0 47 10
7	06 53 58	03 40 07	01	0 17 15	09 10	37	1 31 10	0 48 28
8	07 53 07	04 11 33	01	0 19 43	10 29	38	1 33 38	0 49 47
9	08 52 15	04 43 00	01	0 22 11	11 47	39	1 36 06	0 51 06
10	09 51 23	05 14 26	01	0 24 38	13 06	40	1 38 34	0 52 24
11	10 50 32	05 45 54	02	0 27 06	14 25	41	1 41 02	0 53 43
12	11 49 40	06 17 20	02	0 29 34	15 43	42	1 43 29	0 55 01
13	12 48 49	06 48 47	02	0 32 02	17 02	43	1 45 57	0 56 20
14	13 47 57	07 20 13	02	0 34 30	18 20	44	1 48 25	0 57 39
15	14 47 05	07 51 40	02	0 36 58	19 39	45	1 50 53	0 58 57
16	15 46 13	08 23 06	02	0 39 25	20 58	46	1 53 21	1 00 16
17	16 45 21	08 54 33	02	0 41 53	22 16	47	1 55 49	1 01 34
18	17 44 31	09 26 00	03	0 44 21	23 35	48	1 58 16	1 02 53
19	18 43 39	09 57 27	03	0 46 49	24 53	49	2 00 44	1 04 12
20	19 42 47	10 28 53	03	0 49 17	26 12	50	2 03 12	1 05 30
21	20 41 55	11 00 20	03	0 51 45	27 31	51	2 05 40	1 06 49
22	21 41 03	11 31 47	03	0 54 13	28 49	52	2 08 08	1 08 07
23	22 40 12	12 03 13	03	0 56 40	30 08	53	2 10 36	1 09 26
24	23 39 20	12 34 40	03	0 59 08	31 27	54	2 13 03	1 10 45
25	24 38 29	13 06 07	04	1 01 36	32 45	55	2 15 31	1 12 03
26	25 37 37	13 37 34	04	1 04 04	34 04	56	2 17 59	1 13 22
27	26 36 45	14 09 00	04	1 06 32	35 22	57	2 20 27	1 14 40
28	27 35 54	14 40 27	04	1 09 00	36 41	58	2 22 55	1 15 59
29	28 35 02	15 11 53	04	1 11 27	38 00	59	2 25 23	1 17 18
30	29 34 10	15 43 20	04	1 13 55	39 18	60	2 27 50	1 18 36

LATERCULUS I.

For the finding out the Equation of the Centre.

	Of the Sun.	Of Mars.
A	8.11918.37	8.85180.37
B	9.98150.51	9.89964.78

LATERCULUS II.

For the finding the Distance from the Sun *the former way.*

	Of the Sun.	Of Mars.
C	4.11806.52	4.48437.45
D	4.99987.11	5.17911.95

LATERCULUS III.

For the finding the Distance from the Sun *the latter way.*

	Of the Sun.	Of Mars.
E	$58\vert\underline{05903}$	$10\vert\underline{74610}$
F	6.76374.09	6.21037.05

A Table of the Inclination of Mars.

	The Inclination.			
Degrees.	Sign 0 / Sign 6	Sign 1 / Sign 7	Sign 2 / Sign 8	Degrees.
	Deg. m. s.	Deg. m. s.	Deg. m. s.	
0	00 00 00	00 55 15	01 35 42	30
1	00 01 56	00 56 54	01 36 39	29
2	00 03 52	00 58 32	01 37 34	28
3	00 05 47	01 00 09	01 38 28	27
4	00 07 42	01 01 45	01 39 20	26
5	00 09 38	01 03 21	01 40 10	25
6	00 11 33	01 04 55	01 40 58	24
7	00 13 28	01 06 28	01 41 44	23
8	00 15 23	01 08 00	01 42 28	22
9	00 17 17	01 09 31	01 43 10	21
10	00 19 11	01 11 01	01 43 50	20
11	00 21 05	01 12 30	01 44 28	19
12	00 22 58	01 13 57	01 45 05	18
13	00 24 51	01 15 23	01 45 40	17
14	00 26 43	01 16 47	01 46 13	16
15	00 28 35	01 18 10	01 46 44	15
16	00 30 26	01 19 31	01 47 13	14
17	00 32 17	01 20 50	01 47 40	13
18	00 34 07	01 22 08	01 48 05	12
19	00 35 57	01 23 25	01 48 28	11
20	00 37 46	01 24 40	01 48 49	10
21	00 39 34	01 25 54	01 49 08	9
22	00 41 22	01 27 06	01 49 25	8
23	00 43 09	01 28 16	01 49 40	7
24	00 44 55	01 29 25	01 49 53	6
25	00 46 40	01 30 32	01 50 04	5
26	00 48 25	01 31 37	01 50 13	4
27	00 50 09	01 32 41	01 50 20	3
28	00 51 52	01 33 43	01 50 25	2
29	00 53 34	01 34 43	01 50 28	1
30	00 55 15	01 35 42	01 50 30	0
	Sign 11 / Sign 5	Sign 10 / Sign 4	Sign 9 / Sign 3	

A Table of the Reduction of Mars *to the Ecliptick.*

	The Reduction. Subtract.			
Degrees.	Sign 0 / Sign 6	Sign 1 / Sign 7	Sign 2 / Sign 8	Degrees.
	M. sec.	M. sec.	M. sec.	
0	00 00	00 47	00 47	30
1	00 01	00 48	00 46	29
2	00 03	00 48	00 45	28
3	00 05	00 49	00 44	27
4	00 07	00 49	00 43	26
5	00 09	00 49	00 42	25
6	00 11	00 50	00 41	24
7	00 13	00 50	00 39	23
8	00 15	00 51	00 38	22
9	00 16	00 51	00 37	21
10	00 18	00 52	00 36	20
11	00 20	00 52	00 34	19
12	00 22	00 52	00 33	18
13	00 24	00 52	00 32	17
14	00 26	00 53	00 30	16
15	00 28	00 53	00 28	15
16	00 30	00 53	00 26	14
17	00 32	00 53	00 24	13
18	00 33	00 52	00 22	12
19	00 34	00 52	00 20	11
20	00 36	00 52	00 18	10
21	00 37	00 51	00 16	9
22	00 38	00 51	00 15	8
23	00 39	00 50	00 13	7
24	00 41	00 50	00 11	6
25	00 42	00 49	00 09	5
26	00 43	00 49	00 07	4
27	00 44	00 49	00 05	3
28	00 45	00 48	00 03	2
29	00 46	00 48	00 01	1
30	00 47	00 47	00 00	0
	Sig. 11 / Sign 5	Sig. 10 / Sign 4	Sign 9 / Sign 3	
	Add			

SECTION

SECTION IV.

Shewing how all Lines and Angles may be determin'd from Observations.

PROBLEM. I.

To find the Meridian *Line.*

IN a Plane that is Polish'd, and that is brought to an *Equilibrium* with the Horizon, and firmly fixt, let a great many Circles be drawn from the same Centre, and let there be fixt perpendicularly in the Centre a piece of Wood about three Fingers high, having in the top of it a Copper-plate, through the little Hole of which let a Ray of the Sun pass: And then in the Fore-noon is to be accurately observ'd, and noted with a point, the Incidence of the Sun's Ray upon as many of the Circles that are drawn, as the Ray can come to; and in the After-noon is to be observ'd the Return of the Sun's Rays to the same Circles one after another. Which being done, if all the Arches that lie between the two Correspondent Points be Geometrically cut in two, the Line that cuts them in two is the *Meridian*.

PROBLEM. II.

To find the Elevation of the Pole.

IF by a Quadrant (that is large enough, and exquisitely made, and that is fixt precisely upon the *Meridian* Line,) the greatest as well as least Altitude of any Star, that is near to the Elevated Pole be observ'd; the Half of the Difference of the Altitudes being added to the less, or Substracted from the greater, (or Half of the Summ of the Altitudes,) shews the Elevation of the Pole which is sought for.

PROBLEM. III.

To find the Horizontal Parallax of the Sun.

IF you observe for two days together the Planet *Mars*, when Acronychial, in 90° of the Ecliptick, very diligently marking both the time and his Longitude, (by making Computation of it with reference to the fix'd Stars, in the way hereafter deliver'd,) you may from thence conclude the quantity of the Motion for the time that then passes; whence farther may be computed the Longitude of the same at any intermediate moment of Time. But if at the same intermediate moment his Longitude be again observ'd, by comparing it to the fix'd Stars, while he is in his Corner-Altitude, you shall find the Longitude that is found by Calculation to differ a very little from the Longitude observ'd, which difference will go to the Parallax of Longitude. And seeing at the same moment may be found the Angle, which the Vertical, that passes through *Mars*, does make with the Parallel of the

the Ecliptick: There are in the Rectangular Angle that is made by the Vertical, the Parallel of the Ecliptick, and the Circle of Latitude that passes through *Mars*, all the Angles and one Leg; whereby will be made known the *Hypotenusa*, which will be the Parallax of Altitude to such an Almucantarath, whence will likewise be found out his Horizontal Parallax. Then you may say: As the Distance of the Sun from the Earth is to the distance of *Mars* from the same; so is the Horizontal Parallax of *Mars* to the Horizontal Parallax of the *Sun*. Now, they that have search'd this thing very narrowly, do affirm, That the Parallax of *Mars*, when nearest the Earth, is found to be so very small, that it scarce amounts to any at all, as never coming fully to 1′. Hence therefore I consequently infer, That if the Horizontal Parallax of *Mars*, when Acronychial, which is when He is almost four times nearer the Earth than the *Sun* is, do not come to 1′; then certainly the Parallax of the Sun, which is almost four times farther off, will scarce come to $\frac{1}{4}$ of a Minute. And hence it is, that the Horizontal Parallax of the *Sun* is by Modern Astronomers concluded not to be above 15″. at the most.

PROBLEM. IV.

To find the Obliquity of the Ecliptick.

IF on the Day of the Summer Solstice the Meridian Altitude of the *Sun* be taken, which may be limited by the true Parallax, as if it had been seen from the Centre of the Earth; And if from this Solstitial *Meridian* Altitude, and which is limited by the Parallax, be taken the Altitude of the *Æquator*, or the Complement of the Elevation of the Pole; there remains the greatest Declination of the *Sun*, which they call the Obliquity of the Ecliptick; as for Example: The Solstitial *Meridian* Altitude of the *Sun*, may be concluded to be as great as it was by *Tycho* really observ'd to be, from the Obliquity of the Ecliptick, which he determines, and from the Horizontal Parallax. For he makes the Obliquity of the Ecliptick to be 23°. 31′. 30″. and the Horizontal Parallax 3′. and determines the Elevation of the Pole at *Urenburgh* to be 55°. 54$\frac{1}{2}$′. therefore the Elevation of the *Æquator* was 34°. 5$\frac{1}{2}$′. And that we may conclude the *Meridian* Parallax of the *Sun* from the Horizontal Parallax of three Minutes suppos'd, it is also necessary to know pretty near the Altitude of the same, which was compounded of the Altitude of the *Æquator*, and the greatest Obliquity of the Ecliptick, which supposing for a while with Him to be 23°. 31$\frac{1}{2}$′. we gather the *Meridian* Altitude to be 57°. 37′. which is as great as *Tycho* believ'd it would be, if it was seen from the Centre of the Earth. And to this Altitude agrees the Parallax, 1′. 36$\frac{1}{2}$″. if so be the Horizontal Parallax be suppos'd to 3′. That Parallax therefore 1′. 36$\frac{1}{2}$″. is contain'd together in the supposed Altitude 58°. 37′. Therefore 1′. 36$\frac{1}{2}$″. being subtracted, there remains the Altitude, which is found by Instruments to be 57°. 35′. 23$\frac{1}{2}$″. And then farther adding to this the true Parallax 7$\frac{1}{2}$″. that arises from the supposed Horizontal Parallax 15″. we gather the Solstitial *Meridian* Altitude, limited by the true Parallax to be 57°. 35′. 31″. from whence being taken the Altitude of the *Æquator* 34°. 5′. 30″. there remains the Obliquity of the Ecliptick 23°. 30′. 1″.

PROBLEM. V.

To take the Longitude of the Sun.

AT Noon-day let the Altitude of the Sun be taken, and limited by the true Parallax; then the Difference of the limited Altitude, and of the Elevation of the *Æquator*, will be the Declination of the *Sun*. Whence by the first Inverted Problem of the Spherical part will appear the Longitude of the *Sun*, that is

is sought for. But farther 'tis to be observ'd, if the Observation be made in the Winter-Months, that then the Refractions are to be consider'd: And so to avoid these, the Summer time is us'd rather to be chosen, when the Noon-day Sun has almost got quite out of the Labarinth of Refractions; and if besides, a calm and clear season be chosen, the less Inconvenience will be to be fear'd. Now these things may be the more certainly practised about the *Æquinoxes*, when the Declination is very much changed in a short space: So the *Æquinoxes* themselves are found, the Meridian Altitude of the Sun being sought for, on the very day of the *Æquinox*, or on the next to it; which Meridian Altitude, if when limited by the true Parallax, it be equal to the Elevation of the *Æquator*; 'tis an Argument, that the time of the true *Æquinox* does fall upon the very Noon-day that the observation is made; but if it be less or greater, the *Æquinox* will almost so many hours go before the time of the making of the Observation, or follow it as many Minutes, as there are between the limited Altitude of the Sun, and the Elevation of the *Æquator*; for the greater limited Altitude argues the Vernal *Æquinox* to have gone before the making of the observation, but that the Autumnal *Æquinox* will follow. And the less Altitude denotes the contrary.

PROBLEM VI.

To find the Apogee and Eccentricity of the Sun.

THE three true Longitudes of the Sun are to be found out by the foregoing Problem, avoiding the too great nearness of the Solstices, and the Winter-Signs. Then in Figure XXXVIII. let the Orbit of the Earth be *a b c e*, *s* the Sun, *f* the other *Focus*, let *a b c* be the true places of the Earth, diametrically oppos'd to the observed places of the Sun; now therefore there are given true distances of these places, to wit, the Angles *a s b*, *b s c*, *a s c*; and there are also given the middle Motions of the Sun, that agree with the Temporary Intervals of the Observations *a b*, *b c*, *a c*; which Intervals are known by marking the moments of making the observations, and they have the same proportion to the time of the whole Revolution of the Sun, *viz.* to 365 *d.* 5 *h.* 49 *m.* That the Angles *a f b*, *b f c*, *a f c*, have to the whole Circumference. Nor does it signifie any thing, that there is a difference among the Astronomers about the Seconds and Thirds, above the Hours and Minutes of the Sun's Revolution; for they are here almost of no consideration. Now the Angles at *s* and *f*, being thus given from the Centre *f*, at the compass of *f* A, equal to *d e*, the whole Line of the *Apses*, let there be drawn the Circumference A B C G, which let the right Lines, drawn from the *Focus f* through *a b c*, cut in A B C; and let *s* A, *s* B, *s* C, be joyn'd, the Triangles *s a* A, *s b* B, *s c* C, will be of equal Legs; seeing according to the nature of an Ellipsis to *d e*, (*i. e.* to *f* A,) is equal *s a* + *a f*; wherefore taking away on both sides *f a*, there remains *s a* = *a* A. And therefore the Angle *f a s*, (which is external to the Triangle *a* A *s*,) will be double to the Angle *b* B *s*. Lastly, *f c s* will be double to *c* C *s*. And now take the Angle *a s b* from *a f b*, and there will remain the Summ of the Angles *s a f*, and *s b f*; for the Angle *s a f* is the difference of the parts *a f d*, and *a s d*, and the other Angle *s b f*, is the difference of the rest of the parts *b f d*, and *b s d*. Wherefore when the whole Angles *a s b*, and *a f b* are given, the Summ of the differences *s a f* and *s b f*, will be also given, the summ of whose half *s* A *f*, and *s* B *f*, or *a s* A, and *b s* B, being added to the Angle *a s b*, it gives the Angle A *s* B; and by the same way may be found the Angles B *s* C, and A *s* C. Now there being given after this manner the Angles that are made by the right Lines that are drawn at both *Focusses* to A B C; let A *s* be drawn out to G, and let B G and C G be joyn'd. First in the Triangle *s* B G of the given Angles, (since B *s* G is the complement of the given Angle A *s* B to 180 degrees, and *s* G B is the half of the given Angle A *f* B,) let *s* B be taken and suppos'd to be of as many parts as you please, suppose 100000, *s* G will be found by Trigonometry in the same parts. Again, in the Triangle *s* C G are given, first, *s* G just now found; secondly, G *s* C the complement of the given Angle A *s* C to 180 degrees; thirdly, *s* G C the half of the given Angle A *f* C;

Figure XXXVIII

A f C; Therefore s C will so be found. Farther, in the Triangle B s C are given, first, s B, which was first taken; secondly, s C, just now found; thirdly, B s C, from observations; and therefore s B C and B C will likewise be found. Again, in the Æquicrural Triangle B f C (because f B and f C are Rays of the same Circle) are given all the Angles; for B f C is known from what goes before, and the rest f B C, f C B, together, are its complement to 180 degrees, and the same are also equal to one another; and there is also given the side B C, lately found: so that f B will be found out. Lastly, in the Triangle f s B are given, first, s B, that was taken first of all; secondly, f B, newly found; thirdly, the Angle f B s, s B C, being subtracted from f B C; wherefore both the unknown Angles may be found, and the side f s, the distance of the *Focusses*, in parts, such as s B was taken to be 100000. Whereby may be found the Eccentricity in parts, of which the middle distance of the Earth from the Sun is suppos'd to be 100000, by saying; f B newly found, (and the same is equal to d e, the Diametre of the greater *Ellipsis*,) gives f s, that is also newly found; therefore the ½ of d e, or the middle distance of the Earth from the Sun, suppos'd to be 100000 parts, will give the ½ of f s, or the Eccentricity in like parts. Last of all, you must subtract f B s, that is just now found, or what is equal to it, the Angle b s B, from the given Angle d s B, that there may remain the Angle d s b, which the place of the middle observation b, is distant from the *Aphelion* d. Wherefore the place b, being given by observation, the place of the *Aphelion* of the Earth d is also given. This way of finding the *Aphelion* and Eccentricity, first propos'd by *Herigon*, and afterwards applied by Mr. *Tho. Street*, to the Elliptical *Hypothesis*, (though yet he draws the Circle from the Sun, which I have chose rather to draw from the upper *Focus*, that there might be the greater Agreement between the Lines of Scheme XXXIV. and so the Reader might be wearied with the less variety of Conceptions.) This way, I say, does Geometrically excell both those in the *Hypothesis* of Dr. *Ward*, and of *Count de Pago*; nor is there any thing else wanting in it, but that the *Hypothesis* should agree more with the Heavens. Wherefore that Respect may be had to *Bullialdus*'s Limitation, a repeated operation is necessary, by which through the seat of the Apogée next found, and through the Eccentricity, may be found the middle true Anomaly at three Observations given, as I have taught in the XXII. Chapter; and by those middle true Anomalies, let the Angles to f be corrected, suppose a f b, b f c, a f c, which now must be the differences of the middle true Anomalies, as they were before of the middle ones only: And so following the foregoing Calculation step by step the same way, you may find the *Aphelium* of the Earth, and the Eccentricity very exactly.

PROBLEM VII.

To find the Apogee and Eccentricity of the Sun, by the method us'd by the Ancients.

THey were wont to observe the time of both *Æquinoxes*, *viz.* the Vernal and Autumnal, and also of the Summer Solstice; then they computed the Interval of the time that pass'd between. Now *Hipparchus* found 94 days and ½ from the Vernal *Æquinox* to the Solstice, from the Solstice to the Autumnal *Æquinox* 92 days and ½, which being join'd, do make 187 day: Therefore seeing thus it is found, that the Sun tarries two days longer in the Vernal Quadrant, or Spring Quarter of the Circle, than in the Summer Quarter; it follows, that the Apogée of the Sun, (in which it stays the longest,) is plac'd in the Spring Quadrant.

In Figure XXXIX. let then A be the Earth, from which, as from the Centre of the Universe, let there be describ'd the Ecliptick ♈, ♋, ♎, ♑, and let ♈, ♋, ♎, ♑, be the Cardinal Points; there will be plac'd, as I said, in the Vernal Quadrant, ♈ A ♋, both the place of the Apogée C, and the Centre of the Sun's Eccentrick B; wherefore from the Centre B, let there be describ'd the Eccentrick of the Sun C K M N, and through B, to ♈ ♎, and ♋ ♑, let there be drawn parallel the Lines E Figure XXXIX.

B M, H B N, dividing the Eccentrick into Quadrants. And now the time being given, in which ☉ goes from the begining of ♈, to the beginning of ♋, *viz.* 94 days and $\frac{1}{2}$; there is also given the Arch of the Eccentrick D K, which it goes through in the mean time by its middle Motion, *viz.* 93 degrees, 8′. 37″. So from the beginning of ♋, to the beginning of ♎, in 92 days and $\frac{1}{2}$, the Sun passes through the Arch of the Eccentrick K O, *viz.* 91°. 10′. 21″. Wherefore there is given the whole Arch D K O, of 184°. 18′. 58″. from whence being taken, the Semicircle E K M, there remain the Arches D E and M O, which together are equal to 4°. 18′. 58″. Therefore each of them by it self, for instance D E, will be 2°. 9′. 29″. The Sign of which Arch is D F. 3766 = B G = L A. Again, from the Arch D K of 93°. 8′. 37″. take away D E of 2°. 9′, 29″. there remains E K of 90°. 59′. 8″. from whence again, the Quadrant E H being taken, there remains H K of 59′. 8″. whose Sign is K I, 1720 = L B = A G. Now therefore in the rectangular Triangle A B G, there being given the Legs B G and G A, the Eccentricity A B may be found in parts, of which the Ray of the Eccentrick B C is suppos'd to be 100000: As also the Angle G B A = B A L, which the Line of the *Apses* A C, was formerly distant from the beginning of ♋, *viz.* 24°. 33′. 6″. or according to *Ptolomy*, 24°. 30′. Wherefore the Apogee of the Sun in the time of *Hipparchus* was in 5°. 30′ of ♊. Now in this operation some (*Copernicus* and *Tycho* particularly) do think, a sufficient Certainty of things assum'd is wanting: For the Solstices can scarce be found by an Instrument, because the Declination of the Sun about that time is scarce so alter'd as to be perceiv'd by sense. Yet since the Antients are both said to have observ'd the Solstice, and have made known the time, they found it to happen, though they have not discover'd the manner of observing it; yet it cannot be doubted, but that they were both furnished with, and did really use such means as they could perform it by: For that there is still a way of observing the Solstices, *Gassendus* winesses in his II. Epistle to *Wendelin*, where he says, he found in the year 1626, on the 19th day of *June*, St. N. at *Marseilles*, that the length of the shadow, cast from a *Gnomon* 89321 particles high, was 31766 particles; again, on the 20th day, that it was 31753 part. and on the 21st day, that it was 31751; lastly, on the 22d day, that it was 31759 part. from whence we may thus infer; If on the 20th and 21st days the length of the shadow had been the same, it would have also decreas'd as much on the 19th and 20th days, as it had again increas'd from the 21st to the 22d, and the Solstice would have happen'd at mid-night, between the 20th and 21st days. But now seeing from the 20th to the 21st, it decreases two particles, and from the 21st to the 22d it increases less than it had decreas'd from the 19th to the 20th, 'tis certain, the Solstice had been before the Noon-day of the 21st, but yet was nearer to this, than to the foregoing Meridian; and so that it happen'd the 21st day in the Fore-noon: And, if I be not deceiv'd, *Nicolaus Tagautius* says, the *Chinese* do at this day observe the Solstice, by a way not much unlike this. Whence I am apt to believe, the Ancients might do the same; since 'tis evident, the use of the *Gnomon* was very ancient: And that the Ancients did not err much, (I do not say *Ptolomy*, who did distrust himself too much, but *Hipparchus*, and they that were before him,) in determining the Time of the Solstice, the Ancient Lunar Eclipses, that were observ'd at *Babylon*, do evince, whose Intervals do not admit of any other Seat of the Sun's Apogée, than that which was lately concluded by the foregoing ways, as I have long ago demonstrated, and shall sometime or other, publish to the World from what lies by me, if the matter require it. Hence therefore we argue, that the Apogée of the Sun, from *Hipparchus* to our times, has gone forward a whole Sign.

PROBLEM VIII.

To define the middle Motion of the Sun, and the Tropical Year.

THere is need of two Obſervations, made at very far diſtant Intervals of time, at which the Sun was in the point of the *Æquinox*: And ſeeing from what goes before, both the Eccentricity and the Apogée of the Sun may be known at the time of making both the Ancient and Modern Obſervations; the *Proſthaphæreſis* of the Sun, which it had at the time of the *Æquinox*, cannot lie hid, whereby the true Place of the Sun may be reduc'd to the middle in both Obſervations. Then are to be computed both the whole Tract of Time that comes between both Obſervations, and the whole Revolutions, with the degrees that are over and above, if there be any, which the Sun has finiſh'd in the mean time. Whence, by the Rule of Proportions, you may infer: If in ſo much time (*viz.* in that which has paſt between both obſervations) the Sun has finiſh'd ſo many Revolutions, and moreover ſo many degrees and minutes; in how much time will it go one Circuit by its middle Motion from *Æquinox* to *Æquinox*? For what the Product is, is the Quantity of the middle Tropical Year. And tranſpoſing the Terms of the ſame Proportion, you may ſay; If ſo many Revolutions, and Degrees, and Minutes, have been paſt in ſo great ſpace of Time, *viz.* as has paſt between the two Obſervations; How many Degrees and Minutes muſt be allowed for one Day or one Hour.

PROBLEM IX.

To obſerve the viſible Diametre of the Sun and Moon.

IF to a Lath that is well plain'd and pretty long, be perpendicularly fixed two Plates, the one to the one end, and the other to the other; and the one have a little hole, through which the Rays of the Sun's Diametre may paſs into a dark Chamber, ſo that they may be receiv'd by the oppoſite Plate; there will be painted in this the Image of the Sun, whoſe Diametre is to be taken by a ſharp pair of Compaſſes, and to be meaſured by a certain accurate Scale, deducting the Particles, which the hole takes up: Then by the ſame Scale let the Diſtance of the Plates be meaſur'd, ſo ſhall you find the Proportion, that the diſtance of the Sun from the Earth has to its Diametre. Whence you may farther thus infer; As is the Diſtance of the Sun to its Semidiametre; ſo is the Ray to the Tangent of the Apparent Semidiametre, or the half-Angle, under which the face of the Sun is ſeen. The Semidiametre of the Sun being this way found out, when an Eclipſe of it happens, let the Images of both the Luminaries be taken by a Teleſcope in a dark Chamber, and in that part wherein the Margin or Edge of the Moon does cut the Face of the Sun, let there be taken by a three-pointed Compaſſes three points, here one, and there one in the Circumference of the Moon; and take alſo three points in the Circumference of the Sun: Then when you have found the Centres of theſe three Points, you may compare the Diametre of both Luminaries, and from the Semidiametre of the Sun before known may alſo conclude the Apparent Semidiametre of the Moon.

PROBLEM X.

To find the Eccentricity and Apogee of the Moon.

LET there be taken three Eclipses of the Moon, observ'd within the space of one year, marking accurately both the Moments of Time, and the Places of the Eclip-tick, in which they happen'd: Now the last of these will be known by Calculation by the Place of the Sun, (which is then diametrically opposite to the Moon.) Then to the Intervals of Time between the first and second, as also between the second and third Eclipse, compute from any Tables the Motion both of the middle Anomaly, and of the Apogée of the Moon. For the Motion of the Apogée being deducted from the true Motion of the Moon, (which is known from the Places which it possess'd in every Eclipse,) there remains the Motion of the true Anomaly at the same Intervals. And so returning to the Method explain'd in Prob. VI. there are given there in Scheme XXXVII. the Angles at *f* from the Motion of the Middle Anomaly, and the Angles at *s* from the Motion of the true Anomaly. Wherefore by following the same way of calculating, you will find both the Eccentricity and the Apogée of the Moon.

Figure XXXVII.

PROBLEM XI.

To determine the Horizontal Parallax of the Moon.

LET the time be accurately observ'd, at which the beginning and end of an Eclipse of the Sun does happen, when the apparent Latitude of the Moon is also small or none: For at the same time the Longitude of the Sun, found by Calculation, will differ from the Apparent Latitude of the Moon, as much as the Semidiametres of both Luminaries, when joyned together, do both make. Now how to find out these Semidiametres has been taught Prob. IX. therefore the Apparent Longitude of the Moon will be known, and the true Longitude of the same may be computed to the same Moment, therefore the difference of the true Longitude and the Apparent will be the Parallax of the Moon's Longitude: Whereby may be gathered by Prob. III. the Parallax of Altitude, first at the Almucantarath given, and then the Horizontal Parallax.

PROBLEM XII.

To find the visible Diametre of the Earth's Shadow.

Figure XL.

IN Fig. XL. let *a* be the Sun, *b* the Earth, *c* the Centre of the Shadow, thro' which the Moon *e* does pass, the Apex or Point of which Shadow ends in *d*; let *h g f d* be the visible Horizon, which both Luminaries do touch with their upper Margin or Edge. Now 'tis certain, that right Lines, drawn from the Centre and Surface of the Earth *b* and *g* to the same point of the Sun *h*, will intercept the Angle *g h b*, equal to the Horizontal Parallax of the Sun; As the right Lines drawn from the same Points *b* and *g* to one and the same Point of the Moon *f*, do contain the Angle *b f g*, equal to the Horizontal Parallax of the Moon. And *f b* being drawn out to *i*, *i b h* the external Angle of the Triangle *h b f* will be equal to the Summ of the Horizontal Parallaxes *b h g* and *b f g*. From that Summ therefore *i b h* take away *a b h*, the visible Semidiametre of the Sun, there will remain *i b a* $=$ *c b f*, the apparent Semidiametre of the Earth's Shadow.

PRO-

Fig. XXXIII.

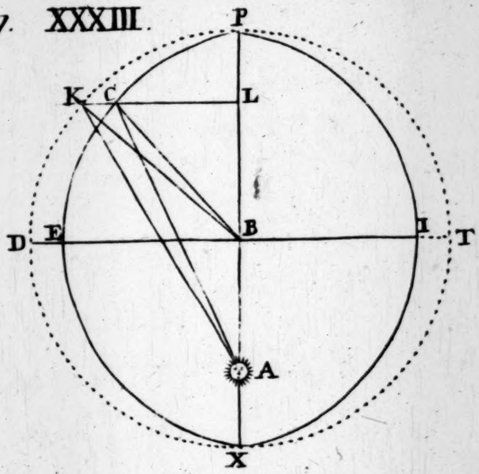


Fig. XXXIV

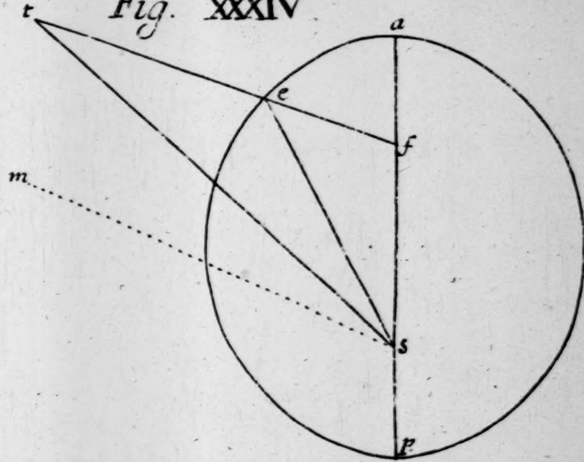


Fig. XXXV.

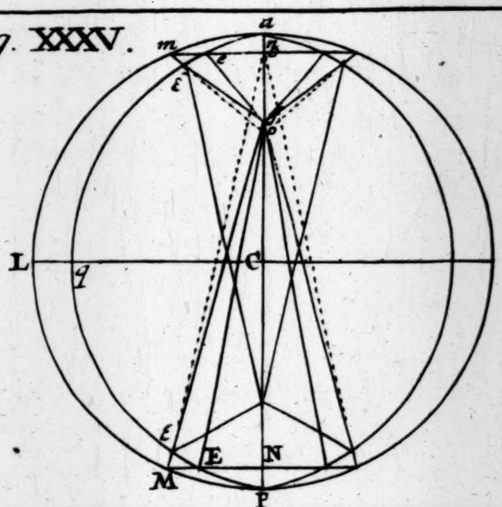


Fig. XXXVI.

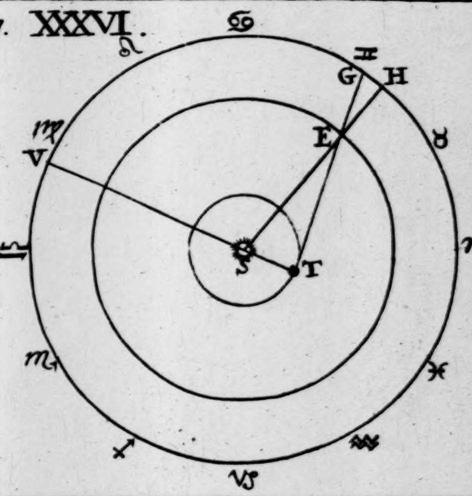


Fig. XXXVII.

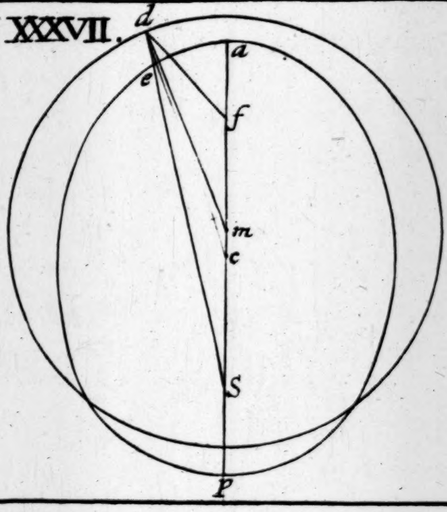


Fig. XXXVIII.

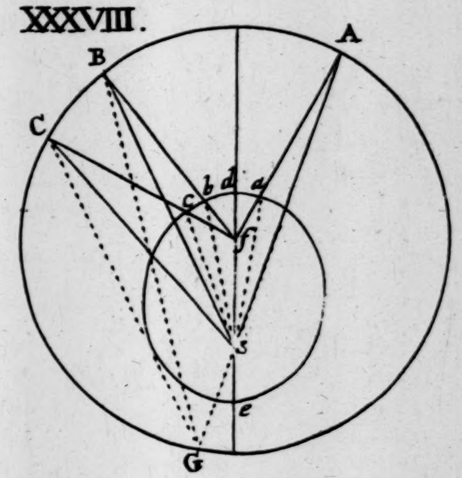


Fig. XXXIX.

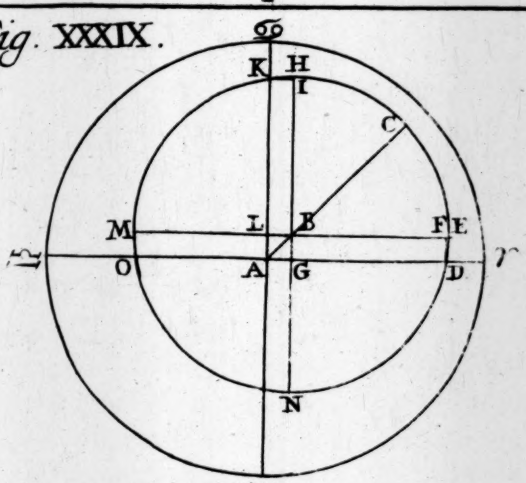
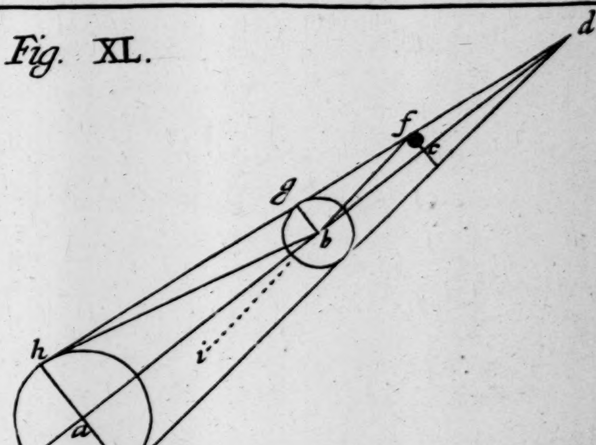


Fig. XL.



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PROBLEM XIII.

To find out the Declination and Right Ascension of the fix'd Stars, and to infer from thence their Longitude and Latitude.

NOW the Declination of a fix'd Star is found by observing its Meridian Altitude, as is also the Declination of the Sun; but the Right Ascension of fix'd Stars has something more difficulty in it. *Tycho* for this purpose chose the Planet *Venus*, when in her greatest Elongation from the Sun, she shines by Day, and is seen after Sun-set. If therefore on the Day-time be taken the Altitude of the Sun by an Azimuthal Quadrant, and also the Altitude and Azimuth of *Venus*; there will in Figure XLI. presently be given the three sides in the Triangle P Z ☉, *First*, The Complement of the observed Altitude of the Sun Z ☉. *Secondly*, P Z the Complement of the Elevation of the Pole. *Thirdly*, P ☉ the Complement of the Declination of the Sun, greater or less than a Quadrant; Z P ☉ is found the Distance of the Sun from the Meridian. Again, in the Triangle P Z ♀ are given, *First*, P Z as before. *Secondly*, Z ♀ the Complement of the observed Altitude of *Venus*. *Thirdly*, P Z ♀ the observed Azimuth of *Venus*: Therefore Z P ♀ is found the Distance of *Venus* from the Meridian. From the Angle Z P ☉ take the Angle Z P ♀, there remains the Angle ☉ P ♀, or the Difference of the Right Ascensions of the Sun and *Venus*. Afterwards when the Sun is set, let the Altitude of the same fix'd Star be taken by the same Quadrant; as also the Altitude and Azimuth of *Venus*: Then in Figure XLII. in the Triangle Z P ✳ there will be given the three sides, *First*, P Z as before. *Secondly*, P ✳ the Complement of the Declination of the fix'd Star. *Thirdly*, Z ✳ the Complement of the observed Altitude of the fix'd Star: Then Z P ✳ is found the Distance of the fix'd Star from the Meridian. Again, in the Triangle Z P ♀ are given, *First*, P Z as before. *Secondly*, P Z ♀ the observed Azimuth of *Venus*. *Thirdly*, Z ♀ the Complement of the observed Altitude of *Venus*; therefore Z P ♀ is found, or the Distance of *Venus* from the Meridian. From the Angle Z P ♀ take the Angle Z P ✳, there remains the Angle ♀ P ✳, or the Difference of the Right Ascensions of *Venus* and the fix'd Star. If therefore the Right Ascension of the Sun be known at the Moment of the first Observation, add to it the difference of the Right Ascensions of the Sun and of *Venus*; so may you make up the Right Ascension of *Venus*. To this you may add the difference of the Right Ascensions of *Venus* and the fix'd Star, and the Right Ascension of the fix'd Star, which is the thing sought for, will appear. But if between the Times of both Observations *Venus* chance to change her Place, and consequently her Right Ascension, (though that cannot but be very small, *Venus* being all that while in her greatest Elongation from the Sun, and so Stationary, or very near it,) the Right Ascension of *Venus*, found by the first Observation will be to be corrected, and to be fitted to the Time of the latter Observation: And so the Declination and Right Ascension of a fix'd Star being this way found, the Longitude and Latitude of the same may be thence inferr'd by the second Converse Problem of the Spherical part of this Astronomy. Now the Right Ascension of one fix'd Star being known, it may lead us to the knowledge of the Right Ascension of all the rest; whence also their Longitudes and Latitudes may be determined.

Figure XLI.

Figure XLII.

PRO-

PROBLEM XIV.

To determine the proper Motion of the fix'd Stars, and the Siderial Year.

THE more famous Astronomers perceive, that the Latitudes of the fix'd Stars are not chang'd. Now therefore if by the foregoing Problem the Latitude of any fix'd Star be found, as for instance of *Spica Virginis*, then it was also the same in Ancient Times; now *Timocharis* did also of old take the Declination of the same fix'd Star: The Declination therefore of *Spica Virginis*, and the Latitude of the same being given, the Longitude of it may be found by the second converse Problem of the Spherical Part; and also the Longitude of the same fix'd Star in these latter years, may be found by the foregoing Problem: Therefore the Ancient Longitude compared with the Modern, will shew how much the fix'd Stars have in the mean time proceeded by their proper Motion of Longitude. Whence will farther appear the yearly Motion of the fix'd Stars; and moreover that Particle of Time, which the Sun spends in passing that little space of the yearly Motion of the fix'd Stars, after it has return'd from the Point of the Ecliptick, which the Star was in the year before, to the same point again, and has indeed completed the Tropical Year; but not finding the same fix'd Star there, yet while it goes on to it, it completes the Siderial Year, which must consequently exceed the Tropical Year, the Proportion of time now spoken of.

PROBLEM XV.

To take the Longitude and Latitude of the Planets.

Figure XLIII. THE Distance of a Planet is to be taken by two fix'd Stars, whose Longitude and Latitude is known. In Figure XLIII. Let the two fix'd Stars be A and B, and the Planet ♂, E C the Ecliptick, and its Poles F F. 1. In the Triangle F A B are given F A and F B, the Complements of the given Latitude of the fix'd Stars, and A F B the difference of the Longitude; and there are found A B and F A B. 2. In the Triangle A B ♂ is given A B, just now found, and A ♂, B ♂ by Observation; and then there is found ♂ A B. 3. In the Triangle ♂ A F are given F A and A ♂, as before, and the Angle ♂ A F, which is to be made up of the Marks ♂ A B and F A B; and so there is found F ♂, the Complement of the Latitude of the Planet, and A F ♂ the difference of the Longitude of the fix'd Star A, and of ♂. Now the Longitude of the fix'd Star A is suppos'd to be given, and therefore the Longitude of ♂ will be given also.

PROBLEM XVI.

To find the Aphelion *or Distance from the Sun, and the Eccentricity of the Superior Planets.*

WHen the Superior Planets are in Opposition to the Sun in their Acronychial Situation, they seem to us, who look upon them from the Earth, to be in the same Degree and Minute of Longitude, that they would seem to be in from the Sun, if the Eye was there plac'd: If therefore, about that time their Longitude be daily observ'd, and the true place of the Sun be computed at the very same Moments

Moments of the Observations; then the very Moment of opposition may be thence concluded, and besides that the true Place of the Sun, to which will be then diametrically oppos'd the true Place of the Planet. Now three Acronychial Observations of this kind are necessary to be made of every Planet, that the *Aphelion* and Eccentricity may be thereby known. For returning to Prob. VI. and Figure XXXVIII. there will be given the Angles at *s*, which will be the Differences of the true places of the Sun, or of the Planet, at the moments of the Observations: And also the Angles at *f* will be set out by the middle Motions of the Planet, which it makes between the two next Observations. From whence by repeating over again the Calculation there shewn, you may gather both the *Aphelion* and the Eccentricity of the upper Planet.

PROBLEM XVII.

To find the Aphelion *and the Eccentricity of the lower Planets.*

Because the lower Planets do never go so far from the Sun, as to come into Opposition with it; therefore here there is need of another Method of finding out the *Aphelion* and the Eccentricity from what there was before; and instead of three Oppositions, three of the greatest Elongations from the Sun are to be taken. Nor does it signifie much, that the Moments of these can scarce be precisely determin'd; because about that time they being Stationary, do scarce alter their Distance from the Sun: For if one do err something in determining the time of the greatest Distance, seeing this distance is the same or near upon it, it will come almost to the same thing. Let then, in Fig. XLIV. S be the Sun, D F E the three Places of the Earth in its Orbit, at its greatest Elongations; and let the Orbit of the lower Planet be P G H I A, and let there be drawn about it the Circle P K L M A. Let the Planet in its greatest Elongation from the Sun be in G, H, and I; and so the Right Lines D G, E H, F I, drawn from the Places of the Earth to these points, will touch the Elliptick Circle, and the same will cut the perfect Circle each of them twice; and the Sections or Points of their cutting, that are the nearer the Sun S, will fall upon K L M; and farther, the Lines S K, S L, S M, drawn from the Sun to these Points, will be perpendicular to the Tangents D G, E L, F M: And so the Triangles D K S, E L S, F M S will be rectangular, and the *Hypotenuses*, or under sides of each of them will be the Distances of the Earth from the Sun, and consequently will be given; and the Angles at D E F, that lie between the right Lines, that are drawn from any place of the Earth to the Sun, and to the point of Contact, will be the greatest Elongations of the Planet, and will be also given. Whence will be likewise not only D S K, E S L, F S M, the Complements of these Angles, but there will also be found the perpendiculars S K, S L, S M. Now these Lines being found, let there be imagin'd three Triangles, lying between Them and the Cords that joyn their ends together, *viz.* K S L, L S M, K S M, in every one of which there are given two sides, (namely the perpendiculars,) and the Angle that is between them. For from D S E (which is either the Angle, or the Complement of the Angle to the four right Angles, computed according to the order of the Signs) if from that, I say, be taken the Angles on each side D S K and E S L, there remains K S L in the middle. Now D S E is the difference of the Places of the Earth in the first and second Observation. So from F S M which is given, you may take F S E, the difference of the Places of the Earth, in the second and third Observation, and there will remain E S M, whch you may also take from E S L which is given, and there will remain M S L. And lastly, K S L + M S L = K S M. Wherefore there being given, as I said, in every Triangle two sides with the Angle contain'd between them, there will be found the Cords K L, L M, K M; And so the Triangle K L M will have two sides given; and therefore the Angle K L M may be also found. And the double of that is the Arch K A M, and again, the Complement or filling up of this to four right Angles is the Arch M L K, and the perpendicular

CN

C N being let fall from C upon M K, there will be made the Angle N C M, the half of the Arch M L K, and the Line M K will be cut in two in N. Therefore there being now given M N and N C M, in the rectangular Triangle C N M, there will be found C M = C A, and also C N. And in the Triangle above mentioned, K S M, (whose sides K S and S M were given together, with the Angle K S M contained between them,) the Angle S K M might also be found. Wherefore now in the rectangular Triangle S O K, there being given S K and S K O, there may be found both the Legs S O and K O. From K N (= M N) take K O, and there remains O N = S Q; and from C N take Q N, (= S O,) and there remains C Q. Wherefore in the rectangular Triangle C Q S, there being given the two Legs C Q and Q S, there may be also found both S C, the Eccentricity that is sought for, and also the Angle C S Q; to which if there be added Q S M, (= S M K, found before in the Triangle S K M,) there will be made up of them C S M, which you must last of all take from F S M which is given, that there may remain F S A, or the Distance of the *Aphelion* of the Planet from the Place of the Earth when in F.

PROBLEM XVIII.

To find the Middle Distance of every Planet from the Sun.

THE middle Distance of the lower Planets was found indeed in the foregoing Problem, to wit, The Line C M or C N; but now the middle distance of the upper may be also found, if their Longitude be observed about the time of their Elongation from the Sun of 90 Degrees: For returning to Fig. XXXVI. in the Triangle S T E are given all the Angles, *viz.* E T S, the difference of the true Place of the Sun, and of the observed Longitude of the Planet; also E S T, the Difference of the true Place of the Earth, and of the Heliocentrick Place of the Planet. Lastly, S T, the Distance of the Earth from the Sun: Therefore there may be found S E, the Distance of the Planet from the Sun, agreeing with such a middle Anomaly of the Planet, as it has at that time, and this in parts, of which the middle Distance of the Earth from the Sun amounts to 100000. Then supposing for a while the middle Distance of the Planet to be of 100000 parts, if according to the same middle Anomaly you compute its distance from the Sun, you may then state the Analogy or Proportion thus: As the distance of the Planet, last found, is to the distance that was found first; so is 100000 to the middle distance of the same from the Sun, in parts, of which the middle distance of the Earth comes to 100000.

Figure LXI.

PROBLEM XIX.

To find the Nodes and greatest Inclination of every Planet.

TWO Observations are to be pitch'd upon, in which the Latitude of the Planet falls upon the same Quadrant of the Orbit: For, that you may not be ignorant of it, there is from the Ascending Node to the Northern Limit the first Quadrant, in which the Latitude is the Northern Ascendent; from the Northern Limit to the descending Node, in the second Quadrant, the Latitude is the Northern Descendent; from thence to the Southern Limit the Latitude is the Southern Descendent; lastly, from the Southern Limit to the Ascending Node, the Latitude is the Southern Ascendent: Therefore at the time of both Observations the Heliocentrick

centrick Place of the Planet is easie to be found by Calculation; as also its Longitude and Latitude that is found by Observation. And then from the Latitude to the Inclination you may argue thus: As the Sign of the Angle to the Earth is to the Sign of the Angle to the Sun; so is the Tangent of the observed Latitude to the Tangent of Inclination. Let these Inclinations or Distances of a Planet from the Ecliptick, beheld from the Sun, be the Arches D A and G B in Fig. XLV. For E C represents the Ecliptick, whose Poles are F F; O R is the Orbit of the Planet plac'd in A, in the first Observation, and in the second in B; and ☊ is the Ascending Node. Now 'tis certain, that in the Triangle A F B there are given A F and B F, the Complements of the Inclinations, as also the Angle A F B, which is the difference of the Heliocentrick Places of the Planet; therefore there will be found F A B = ☊ A D. And moreover in the Triangle ☊ A D which is rectangular at D, there being given A D and ☊ A D; ☊ A cannot be unknown, which is the distance of the Node from the former Heliocentrick Place, nor the Angle A ☊ D, the measure of the greatest Inclination R C.

PROBLEM XX.

To compare the Planets with respect to their Bulk or Magnitude.

CHristian *Hugenius* has done this as well as can be wish'd in his Saturnian System; I shall therefore give the Reader his very words from Page 77 to Page 82, which run thus. *Copernicus* has taught us in his new and divinely invented System, what Proportion the Distances of all the Planets from the Sun have to another; and it is known by the help of the Telescope, how much the Apparent Diametres of them are one bigger than another. The Proportions therefore being compar'd with one another; both of the distance and of the apparent Magnitude, the true Magnitude of the Planets, both with respect to one another, and also with respect to the Sun, is thereby known. And as for *Saturn*, first the Diametre of his Ring, seeing in his least distance from us it is contain'd in an Angle of sixty eight Seconds, (for we find such at the most;) and seeing this least distance of *Saturn* is to the middle distance of the Sun almost eight-fold; it follows, that if *Saturn* was as near us, as the Sun in its middle distance, then the Diametre of his Ring would appear eight times as much as it now appears; that is, nine Minutes and four Seconds. And the Diametre of the Sun, in its middle distance, is thirty Minutes and thirty Seconds; therefore that will be really the Proportion of the Diametre of the Ring or Compass of *Saturn* to the Diametre of the Sun, which 9 Minutes and 4 Seconds have to 30 Minutes and 30 Seconds; that is, almost of 11 to 37. And the Diametre of *Saturn* himself, which I said above is to the Diametre of the Ring as 4 to 9, that is, almost as 5 to 11, will be to the Diametre of the Sun little less than 5 to 37.

But now how great the Diametre of *Saturn* is, compar'd with the Diametre of the Earth cannot be so certainly defin'd. Astronomers do go this way to work to find it: They first bring the space between the Earth and the Sun to a certain number of the Diametres of the Earth, and thence they collect the sought for Proportion of Magnitudes; but in determining that space between the Earth and the Sun, they do vastly differ; and 'tis no wonder they do so, seeing no tolerable Method of measuring it has been as yet found: For whether they endeavour to find it by Ellipticks, or by Dichotomies of the Moon, it might be easily shown, that they labour in vain. Wherefore to me there seems to remain this one way, I'll tell you, by which we may determine, probably at least, concerning the bigness and distance of all the Planets, with regard to the Earth. Let the apparent Diametres of the Planets be taken by the Telescope, and then by these let the Magnitude of every of them compar'd to the Sun be found out; (as I just now gave an Instance of *Saturn*;) and when all things are throughly examin'd, let that Magnitude of the Earth with respect to the rest be taken, which shall seem to best agree with the Order and fit Disposition of the whole System: So when the Proportion of the Diametres of the Earth

and of the other Planets to the Diametre of the Sun ſhall be determin'd; and it is moreover evident, how many of it's own Diametres the Sun is diſtant from us, to wit, by the Angle which it's Apparent Diametre does ſubtend; then the Greatneſs of the Earth, compar'd to the Sun, will be known; and together with that the Diſtance of the Sun, both from the Earth, and from the reſt of the Planets, may be eſtimated by the Diametres of the Earth. This way therefore I think good to go, and therefore as I have juſt now compar'd *Saturn* with the Sun, ſo I will make the like Enquiries as to all the reſt.

The Diametre of *Jupiter*, when he is neareſt to us, does to me ſeem to be ſixty-four Seconds: And ſeeing this Diſtance of his is to the middle Diſtance of the Sun, as 26 to 5; therefore if it be put, as 5 to 26, ſo 64 Seconds to the other number; then 5 minutes 35 Seconds will be found the Bigneſs or the Angle, which the Diametre of *Jupiter* would have, if it ſhould be imagin'd to be as near us as the Sun is in its middle Diſtance. Now the Sun appears to be in Diametre 30 Minutes and 3 Seconds; wherefore that will be the proportion of *Jupiter*'s Diametre to the Sun's, which 5 Minutes, 55 Seconds have to 30 Minutes, 30 Seconds; that is, a little more than 1 to 5 $\frac{1}{2}$.

I alſo accurately meaſur'd the Diametre of *Venus* by the Method I ſhall by and by Explain; and I found that when ſhe is neareſt the Earth, it is no greater than eighty five Seconds. Now this Diſtance of *Venus* in her *Perigee*, to the middle diſtance of the Sun from the Earth, is as 21 to 82, or thereabouts: Therefore if *Venus* ſhould be in the place of the Sun, her Diametre would appear to be only 21 Seconds, and 46 Thirds. Whence 'tis plain, that the Diametre of *Venus* is to the Sun's Diametre, as 21 Seconds and 46 Thirds, are to 30 Minutes and 30 Seconds; that is, as 1 to 84.

But as for the Diametre of *Mars*, when neareſt the Earth, I found it not to exceed 30 Seconds; though not by ſo exact Obſervation, as I us'd in *Saturn*, *Jupiter*, and *Venus*; becauſe I had not then found out its proportion at *Mars*'s neareſt Approach to the Earth: Wherefore ſeeing the leaſt Diſtance of *Mars* is to the middle Diſtance of the Sun, as 15 to 41, the Proportion of the Diametre of *Mars* to the Diamtre of the Sun, is gather'd to be about that of 1 to 166. Therefore this way *Mars* is made to be twice as little as *Venus*, as to his Diametre. And ſo it is manifeſt, that in the Planets that Order is not kept throughout them all, that they that are fartheſt from the Sun are alſo greateſt in Bulk; for even the Compaſs of *Jupiter* too is found to be greater than *Saturn* without his Ring. Whence it happens, that one cannot ſo clearly make an Eſtimate of the Proportion of the Earth to the reſt of the Planets: For if Bigneſs was to be attributed to them, according to their order, ſo that *Saturn* muſt be bigger than *Jupiter*, *Jupiter* than *Mars*, *Mars* bigger than *Venus*, and ſhe than *Mercury*; then one might indeed almoſt certainly gather, that the Bigneſs of the Earth muſt be between *Mars* and *Venus*: But ſince the Contrary is found in ſome, it does not equally appear what is to be followed. Nevertheleſs that the Congruity of the whole Syſtem may be obſerv'd, as much as may be, it ſeems now to be moſt agreeable to it, that as the Earth is for place in the midſt between *Mars* and *Venus*, ſo it is alſo in Magnitude. I have ſaid above, that the Diametre of *Mars* is $\frac{1}{166}$ of the Diametre of the Sun, and the Diametre of *Venus* to be $\frac{1}{84}$. Therefore reckoning the Diametre of the Earth to be between theſe two, it muſt be $\frac{1}{111}$ of the Diametre of the Sun. Now $\frac{5}{37}$ of this are found equal to the Diametre of *Saturn*; therefore the Diametre of *Saturn* will contain fifteen times the Diametre of the Earth; And the Diametre of the Ring of *Saturn* will contain the ſame Diametre of the Earth about thirty four times; whereby the greateſt Magnitude of theſe Bodies is known, which does indeed much exceed all that has been hitherto deliver'd by others.

And hence alſo the Space between the Earth and the Sun muſt neceſſarily be made greater than all ſuppoſe it; For if the Diametre of the Earth contain $\frac{1}{111}$ of the Diametre of the Sun, and the Diametre of the Sun equal $\frac{1}{113}$ of its middle Diſtance from us, (as it follows it muſt, becauſe its Diametre is obſerv'd to be 30 Minutes, and 30 Seconds,) then the Diametre of the Earth will certainly be $\frac{1}{12543}$ of the Diſtance that is between it and the Sun. Again, ſeeing the leaſt Diſtance of *Saturn* is almoſt eight times as much as the middle Diſtance of the Sun, therefore when *Saturn* is neareſt the Earth, his Diſtance will be reckon'd to be 100344 of the Earth's Diametre's; and when it is very far off, about 122000.

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I confess indeed, that these things are so far grounded upon a slippery Foundation, in as much as we have taken the Magnitude of the Earth to be between that of *Mars* and *Venus*, upon no other grounds but those of probability, and so we may have easily erred some thousands of Diametres from the true Estimate. But as we have now defin'd those spaces to be twice, or even thrice, greater or less than really they are; yet it ought to be accounted no little thing, that we have thus far taken the measure of them, since there is no other way, in which ten times a greater Error is not to be fear'd; for so I am clearly of Opinion: But as for the rest of the Calculation, by which we have compar'd the Diametres of the Planets to the Diametre of the Sun, there is, you must know, nothing in it built upon conjecture, but it proceeds upon such things, as are grounded upon certain Reasons. And so these apparent Diametres of the Planets, which I have told you, have been observ'd by me, being thus suppos'd, the Diametre of the Sun cannot but be to the Diametre of the Ring that surrounds *Venus*, as 37 to 11; and to the Diametre of *Saturn* himself, as 37 to 5; to the Diametre of *Jupiter* as 11 to 2; to that of *Mars*, as 166 to 1; to that of *Venus*, as 84 to 1. As for *Mercury* I will determine nothing about him, before I have exactly measured him; which I have not hitherto been able to doe successfully, both because of the littleness of his Body, and also because he is for the most part found near the Horizon, where the Vapours that arise from the Earth by a sort of trembling Refraction will not suffer the Compass of his Figure to be precisely determin'd. But it's also farther manifest, that the Diametre of the Globe of *Saturn* has to the Diametre of *Jupiter* the Proportion of 55 to 74; and that it does contain the Diametre of *Mars* more than two and twenty times, and is to the Diametre of *Venus* as 34 to 3. Also that the Diametre of *Jupiter* is more than thirty times the Diametre of *Mars*, and but fifteen times more than that of *Venus*; and lastly that the Diametre of *Mars* is about subduple to the Diametre of *Venus*. All which Proportions will remain fixt and settled, let the Distance between the Sun and the Earth be determin'd to be what it will, if so be the apparent Diametres be held to be, as they are now deliver'd.

SECTION V.

Of computing the Motions of the Planets by Tables.

There are scarce any Tables give us a truer Calculation of the Moon and of the Eclipses, than those of *Tycho Brahe*; but to perfect it, there is also requir'd the Motion of the Sun: And therefore I give you out of *Tycho*, first, the *Solar*; second, the *Lunar*; third, the *Lunæ-Solar* Tables. The Motions of the rest of the Planets are best gather'd from the *Rudolphine* Tables, which *Kepler* compos'd chiefly out of *Tycho's* observations; but which I have brought into a more commodious form, applying the Division of the Circle, and of the degrees, to Decimal parts. Yet the *Philolaick* and the *Caroline* Tables, do give us more rightly the Motion of *Mercury*; because the Authors of them were help'd by those Observations which *Kepler* had wish'd for in vain: But that I may not curtail, or blend the Labours of divers persons, I suppose it better to refer the curious Reader to the Authors now mention'd. Yet here let him take an Index of those Tables, which I thought fit to subjoin to this work.

1. *Tycho's* Solar Tables.

I. Tycho's *Solar* Epochæ, *according to the Meridian of* Urenburgh.
II. *A Table of twenty expanded Years.*
III. *A Table of Months in a common Year.*
IV. *A Table of Days.*
V. *An horary Table of the Sun.*

2. *Tycho's* Lunar Tables.

VI. *Lunar* Epochæ, *instituted by* Tycho *himself, serving for the four next following Ages.*
VII. *A Table of twenty expanded Years.*
VIII. *A Table of Months in a common Year.*
IX. *A Table of Days.*
X. *An horary Table of the Moon.*
XI. *The* Prosthaphæreses *of the Sun and Moon jointly shewn, with the Elongation of the Moon from the Centre of the Eccentrick.*
XII. *The second and third* Prosthaphæresis *of the Moon.*

3. *Tycho's* Lunæ-Solar Tables.

XIII. Epochæ, *or Roots, for the Meridian of* Friezland.
XIV. *A Table of twenty expanded Years.*
XV. *A Table of Months in a common Year.*
XVI. *The Canon of the Full and New Moons.*
XVII. *A Table of Lunar Months.*
XVIII. *The Reduction of the Moon to the Ecliptick.*
XIX. *The* Prosthaphæreses *or Equations of the Nodes of the Moon.*
XX. *A Table of the Moons Latitude.*
XXI. *A Table of the Parallaxes of the Sun and Moon in the vertical Circle.*
XXII. *A Table of the Refractions of the Sun and Moon.*
XXIII. *A Table of the apparent Semidiametres.*
XXIV. *A Table of the true horary Motion of the Moon in the true Syzygies, and half a day before and after the Syzygies.*

4. *Rudolphus's* Tables, calculated in decimal parts of a Circle and Degrees.

XXV. *The* Epochæ *of the middle Motions of the Sun and Fixed Stars.*
XXVI. *The middle Motion of the Sun from* Aries, *in the expanded Years, Months, Days, Hours and Scruples.*
XXVII. *A Table of the Conversion of the decimal parts of a Circle into Degrees and decimal Parts of Degrees.*
XXVIII. *A Table of the Equation of the Centre of the Sun.*
XXIX. *A Table of the middle Motions of* Saturn.
XXX. *A Table of the Equation of the Centre of* Saturn.
XXXI. *A Table of the Inclination of* Saturn, *and of his Reduction to the Ecliptick.*
XXXII. *A Table of the middle Motions of* Jupiter.
XXXIII. *A Table of the Equation of the Centre of* Jupiter.
XXXIV. *A Table of the Inclination of* Jupiter, *and of his Reduction to the Ecliptick.*
XXXV. *A Table of the middle Motions of* Mars.
XXXVI. *A Table of the Equation of the Centre of* Mars.
XXXVII. *A Table of the Inclination of* Mars, *and of his Reduction to the Ecliptick.*
XXXVIII. *A Table of the middle Motions of* Venus.
XXXIX. *A Table of the Equation of the Centre of* Venus.
XL. *A Table of the Inclination of* Venus, *and of her Reduction to the Ecliptick.*
XLI. *A Table of the middle Motions of* Mercury.
XLII. *A Table of the Equation of the Centre of* Mercury.
XLIII. *A Table of the Inclination of* Mercury, *and of his Reduction to the Ecliptick.*
XLIV. *A Catalogue of the most eminent Fixed Stars.*
XLV. *A Table of Declinations, and of the Angles of the Ecliptick and Meridian.*
XLVI. *A Table of Right Ascensions.*
XLVII. *A Catalogue of Eminent Places, shewing their Meridian from* Urenburgh, *and Latitude from the* Æquator.

Now follows the use of the Tables, shewn by Precepts and Examples.

PRO-

PROBLEM I.

To turn usual Time into Astronomical.

THat usual Time may be fit to be admitted into the Tables, it stands in need of a threefold Correction.

1. The Current Day of usual Time falls either into Bissextile or Leap-year, after *February* is compleatly at an end, or else upon some other time. In the former case, if the Hours given be in the Forenoon, let one be taken from the given number of Days; but if the Hours be in the Afternoon, let nothing be taken away, and you shall have the compleat Astronomical Day. In the latter case, if the Hours be in the Forenoon, let two be taken from the number of the Days that are given; but if they be in the Afternoon, let one be taken away; and you shall have again the compleat Astronomical Day: Now the Hours in the Afternoon remain as they were given, but to those in the Forenoon the number of twelve is always added, and the Minutes or Seconds, *&c.* being also added, as they were given, there will appear the Astronomical Time; for *Tycho's* Tables change nothing in Years or Months, but as both Current Months and Years are given, so also the Tables exhibit no other: But the *Rudolphine* are compil'd according to compleat Years and Months, and those too from the *Julian* Period; wherefore when a Current Year is propos'd, whether it be of a *Julian* Period, or from the Year of our Lord's Nativity, let there always be one taken from it; and to the year of our Lord, after one has been taken away, let there be farther added the number 4713, that it may be brought to the compleat year of the *Julian* Period. And now the particulars I have said of Days and Hours, let them be taken from *Tycho's* Solar and Lunar Tables, and also from the *Rudolphine*: But also in the *Lunæ-Solar* Tables of *Tycho*, you must cautiously observe, that in every Leap-year, after *February* is at an end, you always take one from the number of the Days that is found; but at all other times, that you take away nothing; and then will be evident the Current Day of the middle *Syzygy*, with the Hours and Minutes of the same day that are pass'd after midnight. Wherefore if you examine any thing by the Solar and Lunar Tables, you must compute the Hours and Minutes from Noon-day, adding 12 hours, if they are in the Forenoon, and casting away one from the number of the days, that the compleat Astronomical day may remain: But if the Hours be in the Afternoon, then let nothing be taken from the number of the days before determin'd; but from the hours that were before computed from Midnight, let 12 be taken, that now they may be computed from the middle of the compleat Astronomical day, as I intimated above.

2. Again, Time is to be equall'd just the same way that I taught above in the little Treatise I inserted concerning my new Method, by the help of a twofold Table, which is there given; but this must be done with this Caution, that as often as the Apparent Time (which is what is commonly exhibited) is to be turn'd into Astronomical, you must always take away 7 Min. 53 Sec. after you have done all the rest; but on the contrary, when the Astromical Time is to be turn'd into Apparent, you must add 7 Min. 53 Sec. besides all other things: And you must know that this holds as well in the Solar Tables of *Tycho*, as in all the *Rudolphine*, but in the *Lunar* and *Lunæ-Solar* Tables of *Tycho*, only the first part of the Table of the Equation of time is to be made use of, taking no notice neither of the said 7 Min. and 53 Seconds.

3. Farther, the time of every place is to be reduc'd to the Meridian of the Tables, by the help of the Catalogue of Places, which follows the Series of the Tables. For those places which are more Eastwarst than *Urenburgh*, will subtract the Minutes express'd in the Catalogue from the Hours and Minutes that are given; but those that are more Westward will add, that the time may appear which agrees with the Meridian of *Urenburgh*. And this likewise holds in *Tycho's* Solar and Lunar Tables, and in all the *Rudolphine*; but the *Lunæ-Solar* Tables of *Tycho*, seeing they were fitted to the Meridian of *Friezland*, which is distant from *Urenburgh* Westward, hour 0. min. 25. you must first of all add always to the time of the *Syzygy*, when found,

52 Min-

25 Minutes, and then you will have the time according to the Meridian of *Vrenburgh*; to which you must afterwards add or subtract the minutes found for any other place in the Catalogue, just the same way that I shew'd before.

PROBLEM II.

To compute the place of the Sun by Tycho's *Solar Tables.*

IN the Year 1662. in the Month of *March*, let the Apparent Time be given, 8 current or common days, 2 hours in the Forenoon, and 29 minutes, at *London*; at which time we are to find the true place of the Sun. The usual time given, being turn'd by the foregoing Problem into Astronomical, is the year of 1662, 6 compleat days in the Month of *March*, 15 hours, 17 minutes, and 40 Seconds. For seeing the time given does fall in Leap-year, after *February* is ended, and the hours being in the Forenoon; I take two from the given number of the days, but to the hours (because they are in the Forenoon) I add twelve; so thence come six complete days in *March*, fourteen hours, and twenty nine Minutes; then with the true place of the Sun, *viz*. twenty seven Degrees, and fifty two Minutes of ♓, I take (out of the above written Tables) the first part of the Equation of Time, *viz*. Min. 0. Sec. 43. A. and with the Anomaly of the Sun, which is 8 Signs, 19 Deg. and 25 Min. I take the latter part of the Equation of Time, that is, 7 Min. and 50 Sec. A. Therefore the absolute Equation of Time is 8 Min. 33 Sec. A. whence being cast (as is always to be done) 7 Min. 53 Sec. there remain Min. 0. Sec. 40. A. Wherefore the equall'd time for the Meridian of *London* is 6 complete days of *March*, 14 hours, 29 Min. 40 Sec. Lastly, in the Catalogue of Places, (Table XLVII.) I find the differences of the Meridians of *London* and *Vrenburgh* to be 48 Min. that *London* is more Westward; which being farther added, the equall'd Time is made up for the Meridian of *Vrenburgh*, as was said above, with which I go to *Tycho's* Solar Tables, setting the Numbers as follows:

	The Sun's Motion.				*Anom. of the Sun.*				
	Si.	de.	min.	sec.	Si.	de.	min.	sec.	
1601	09	20	55	12	06	15	15	27	Tab. I.
60	00	00	27	43	11	29	42	43	II.
1	11	29	45	41	11	29	44	55	II.
Mart.	01	28	59	11	01	28	09	04	III.
d. 6	00	05	04	50	00	05	54	50	IV.
h. 15	00	00	36	58	00	00	36	58	V.
m. 17	00	00	00	42	00	00	00	42	V.
s. 40	00	00	00	02	00	00	00	02	V.
	11	25	50	19	08	19	24	41	

With the collected Anomaly of 8 Signs, 19 Deg. 24 Min. 41 Sec. I take out of Table XI. the *Prosthaphæresis* of the Sun 2 Deg. 1 Min. 51 Sec. A. which being also added (as the Title directs) to the middle Motion, which is 11 Signs, 25 Deg. 50 Min. 19 Sec. it makes the true Place of the Sun 11 Signs, 27 Deg. 52 Min. and 10 Seconds.

PRO-

PROBLEM III.

To compute the Longitude of the Moon.

IN the Year of our Lord 1587. on the eighteenth of *August*, current day, seven hours and twenty five Minutes after Mid-night, the true Place of the Moon was by *Tycho*'s Instruments observ'd to be twenty six Degrees and twenty three Minutes in *Gemini*. First there is to be found at the time given the true Place of the Sun by the foregoing Problem. Now the Astronomical Time that is fitted for that is the year 1587. *August*, sixteen Days, nineteen Hours, and eighteen Minutes, and the middle Place of the Sun is five Signs, five Degrees, fifty Minutes, twenty one Seconds. Now the Anomaly is two Signs, 0 Degrees, twenty Minutes, four Seconds; to which answers the *Prosthaphæresis*, one Degree, forty five Minutes, nine Seconds S. Wherefore the true Place of the Sun is four Degrees, five Minutes, twelve Seconds ♍. Then the same time that is given is to be adapted according to the Lunar Tables; and it becomes Astronomical, the Year 1687. *August*, sixteen Days, nineteen Hours, twenty two Minutes, and thirty seven Seconds: with which I go to the Lunar Tables, placing the Numbers as follows:

		Long. of the Moon from the Sun.				*The Anomaly of the Moon.*				*The Motion of the Lat. of the Moon.*			
		Si.	de.	min.	sec.	Sig.	de.	min.	sec.	Si.	de.	min.	sec.
Tab. VI.	1501	4	22	13	19	10	11	59	11	0	16	47	17
VII.	80	5	23	39	07	05	08	48	20	9	11	35	49
VII.	6	2	09	55	43	06	05	22	40	6	05	30	18
VIII.	Aug.	2	04	26	19	08	09	46	35	9	14	37	20
IX.	d. 16	6	15	03	07	06	29	02	23	7	01	40	11
X.	h. 19	0	09	39	04	00	10	20	35	0	10	28	25
X.	m. 32	0	00	16	15	00	00	17	25	0	00	17	38
X.	sec. 37	0	00	00	19	00	00	00	20	0	00	00	20
		9	25	13	13	01	15	37	29	9	00	57	18

With the Anomaly of the Moon, 1 Sig. 15 Deg. out of Tab. XI. I take the *Prosthaphæresis* 3 Deg. 26 Min. 59 Sec. and for 37 Min. 29 Sec. I gather the proportional part, 2 Min. 17 Sec. to be added, that the *Prosthaphæresis* may answer the whole motion of the Anomaly, 3 Deg. 29 Min, 16 Sec. S. And to the same Anomaly does there answer the Elongation of the Moon from the Centre of the Eccentrick 102217, which is in Fig. XXVII. the Line E *e*, for that Figure is accomodated to this Calculation.

Then to the Motion of the Sun from *Aries* add the Longitude of the Moon from the Sun.

	Sig.	*Deg.*	*Min.*	*Sec.*	
The middle Motion of the Sun	05	05	50	21	
The Longitude of the Moon from the Sun	09	25	13	13	
The middle Distance of the Moon from *Aries*	03	01	03	34	
The Epicyclical *Prostaphæresis*	00	03	29	16	S
The Distance of the Moon from *Aries* first equall'd	02	27	34	18	Subt.
The true Motion of the Sun	05	04	05	12	
The almost true Distance of the Luminaries	09	23	29	06	
The same doubled	07	16	58	12	

To

To this double distance of the Luminaries does answer the Motion of the Centre of the Eccentrick in the little Circle, such as is the Circumference A L E in the Figure mention'd. With that Circumference therefore go to Tab. XII. where you shall find, agreeing with 7 Signs, 17 Deg. the Eccentricity 3987, which is the Line A E; as also the variation of the Centre of the greater Epicycle, agreeing with 29 Min. 36 Sec. S. The Excess of the Circumference A L E above the Semicircle is 46 Deg. 58 Min. 12 Sec. the half of which, *viz.* 23 Deg. 29 Min. 6 Sec. is equal to the Angle E A H or B E R, which is call'd the Angle of the second Equation. For the Angle B E C is the simple Anomaly, B E *e* is the Anomaly first equall'd, and R E *e* is the Anomaly a second time equall'd: Therefore from the

	Sig.	deg.	min.	sec.
Middle Anomaly B E C	01	15	37	29
Take away the Epicyclical *Prosthaphæresis* C E	00	03	29	16 S.
There rests the Anom. first equall'd B E	01	12	08	13
Take away again B E R	00	23	29	06
There rests the Anom. a second time equall'd R E *e*	00	18	38	07

Thus then there are given in the Triangle A E *e* the two sides E *e* 102217, and A E 3987, with the External Angle R E *e*; And so by Trigonometry will be found the *Prosthaphæresis* of the Eccentricity A *e* E 41 min. 21 sec. which is to be subtracted.

We have therefore now three *Prosthaphæreses* of the Moon. 1 The Epicyclical, which is of 3 deg. 29 min. 16 sec. S. 2. That of Eccentricity which is of 0 deg. 41 min. 21 sec. S. 3. That of the Variation, *viz.* 29 min. 36 sec. S. Which since they are all of the same sort, to wit, each of them subtractive; therefore being added into one Summ, they make the absolute *Prosthaphæresis* of the Moon 4 deg. 40 min. 13 sec. which is to be subtracted from the middle Distance of the Moon before found.

	Sig.	deg.	min.	sec.
The middle Distance of the Moon from *Aries*	03	01	03	34
The Absolute *Prosthaphæresis*	00	04	40	13 S.
The Remainder will be	02	26	23	21

Which is the true Distance of the Moon from the beginning of *Aries*. Lastly, the middle motion of Latitude being equall'd by the said Absolute *Prosthaphæresis*, the true middle Motion of Latitude will be then given.

	Sig.	deg.	min.	sec.
The middle motion of Latitude	09	00	57	18
The Absolute *Prosthraph*	00	04	40	13 S.
The true Motion of Latitude	08	26	17	05

With which the Table of Reduction, *viz.* the XVIII. is to be gone to, which will afford 54 sec. to be subtracted, that the true place of the Moon in the Ecliptick, *viz.* ♊ 26 deg. 22 min. 27 sec. may agree exactly enough with Observation.

PRO-

PROBLEM IV.

To Compute the Time of the middle Syzygy by the Lunæ-Solar *Tables, and the middle Motions which agree with that time,* viz. *The Anomaly of the Sun, the Anomaly of the Moon, the Motion of the Moon's Latitude, and the Sun's Motion from* Aries.

AS for Instance, let the thing sought for be the Time of the Full Moon, which happens in the year 1656 in the Month of *January*, together with the middle Motions, that agree with that time. Let the numbers be taken out of the XIII. XIV. XV. XVI. and plac'd as follow.

	The Epact.	*The Anomaly of the Sun.*	*The Anomaly of the Moon.*	*Motion of the Moon's Latitude.*	*Motion of Sol from* Aries.	
	D. ho. mi. sec.	*Si. de. mi. sec.*	*Si. de. mi. sec.*	*Si. de. mi. sec.*	*Si. de. mi. sec.*	
1601	06 20 11 45	06 08 02 20	01 24 48 14	00 01 53 27	09 13 42 04	Tab. XIII.
40	21 21 18 08	11 08 14 07	05 03 26 30	01 01 14 24	11 08 44 05	XIV.
15	14 20 10 18	11 14 33 42	03 06 05 12	09 04 02 51	11 14 44 56	XIV.
Jan.	00 00 00 00	00 00 00 00	00 00 00 00	00 00 00 00	00 00 00 00	XV.
	43 13 40 11					
	45 07 06 05	01 13 39 31	07 08 43 30	07 16 00 21	01 13 39 36	XVI.
Jan.	01 17 25 54	06 14 29 40	05 13 03 26	05 23 11 03	09 20 50 41	

Let the Epacts that are taken out of the XIII. XIV. XV. Tables be gather'd into one Summ, which will here be 43 days, 13 hours, 40 min. 11 sec. With this Summ of the Epacts go to the XVI, which is the Canon or Rule of Full Moon and New; and seeing the Full Moon is sought for in this place, the Number of days, that is next of all greater or above our Number, and that answers to the Full Moon, is found to be 45 d. 7 h. 6 min. 5 sec. which I write out, together with the middle Motions that are in the same Division; and the Epacts before gather'd from the Time writ out, I take away, but collect all the middle Motions into one: So there appears the Time of the middle Full Moon, *Jan.* 1 d. 17 ho. 25 min. 54 sec. and the Anomaly of the Sun, that agrees with that moment of time is 6 sig. 14 deg. 29 min. 40 sec. *&c.*

PROBLEM V.

Any Year being Propos'd, to find out the Months and Days in which Eclipses of the Sun or Moon may happen.

THe Full Moon may be Ecclips'd, when in the Time of the middle Syzygy the Motion of the Moon's Latitude is between 11 Signs, 14 Degrees, 48 Minutes, and 0 Sig. 15 Deg. 12 Min. And also between 5 Signs, 14 Deg. 48 Min. and 6 Sig. 15 Deg. 12 Min. And the New Moon may Eclipse the Sun, when in the time of the

the middle Syzygy the Motion of the Moon's Latitude is between 11 Sig. 18 Deg. 38 Min. and 0 Sig. 20 Deg. 41 Min. As also between 5 Sig. 9 deg. 19 min. and 6 sig. 11 deg. 12 min. And now let the year propos'd be 1668, I would know, what Days and Months of this year there will happen any Eclipses: For since the Argument of the Eclipse is taken in this place from the middle Syzygy of the Luminaries, it is not necessary, that therefore we must needs conclude, that there will certainly be an Eclipse of the Sun or Moon. For it may be, that the Moon, which at the time of the middle Syzygy was within the Bounds of Eclipsing, may at the time of the true Syzygy, be either not come to them, or may be gone beyond them, according as the true Syzygy either goes before or follows the middle one. And therefore we only say, that it is possible, that when the Moon is within the Bounds before mentioned, there may be an Eclipse of the Sun or Moon. But whether it be to be certainly expected, is to be learnt from the Time of the true Full Moon in a Lunar Eclipse, or from the time of the Apparent Conjunction in a Solar one. Let us therefore first of all enquire, what days of the year mention'd a Lunar Eclipse may be suspected to fall. Wherefore by the Method deliver'd in the Fore-going Problem; let the time of the middle Full Moon be sought for, that happens in the Month of *January*, together with the middle Motion of Latitude that agrees with it.

	The Epact.				*Motion of the Moon's Latitude.*			
	D.	ho.	min.	sec.	Sig.	deg.	min.	sec.
1601	06	20	11	45	00	01	53	27
60	03	07	13	07	02	17	31	50
7	16	08	51	30	03	27	39	55
1668	26	12	16	22				
	45	07	06	05	07	16	00	21
January	18	18	49	43	02	03	05	33

The first middle Full Moon of the said Year, is found to be *Jan.* 18 *d.* 18 *h.* 49 min. 43 sec. and the Moon's Motion of Latitude 2 sig. 3 deg. 5 min. 33 sec. which is evidently out of the Bounds of Eclipsing; whence 'tis plain, that no Lunar Eclipse is to be expected that Month. And seeing the Bounds of Eclipsing next following, which are above laid down, are these, *viz.* 5 sig. 14 deg. 48 min. which is that on this side; and the farther, that is beyond, 6 sig. 15 degr. 12 min. Therefore it is no difficult Thing to gather from hence, how much the middle Motion of Latitude above is distant from each of these Bounds.

	Sig.	deg.	min.		Si.	de.	mi.
From each of the said bounds	05	14	48	and	06	15	12
Take the Motion of Latitude before found	02	03	06		02	03	06
There rests the dist. of ☽ from the Bounds of Eclipsing	03	11	42	and	04	12	06

With both these Distances go to Table the XVII. which is of Lunar Months, seeking there under the Title of Motion of Latitude the Number which is between the 3 sig. 11. degr. 42 min. that were just now found: And you shall find 4 sig. 2 deg. 4 min. 56 sec. the number, that answers the four Lunar Months, and so the Time that agrees with so many Months. 118 *d.* 2 *h.* 56. m. 13. Sec. Therefore to the time of the first Full moon, that was found, add the time of four Months, and to the Motion of Latitude of that time reckon the Motion of Latitude of these 4 Months.

Jan.

	D.	ho.	min.	sec.	Sig.	deg.	min.	sec.
Jan.	18	18	49	43	02	03	05	33
	118	02	56	13	04	02	40	56
	136	21	45	56	06	05	46	29

So there appears the Current Day from the beginning of the Year, *viz.* 136 *d.* 21 *h.* 45 *min.* 56 *sec.* And the Motion of Latitude, that answers the said time, *viz.* 6 sig. 5. deg. 46 min. 29 sec. Which seeing it is between the Bounds of Eclipsing before assign'd, we gather thence that it is possible an Eclipse of the Moon may happen at that time. And if you enquire farther, what day and of what Month, that day is, Searching in the little Table which is added, and that in the little Columne of Leap-year (because the year 1668 is such) the number of days that is the next number less than that which was before made up by Addition; which is here found to be 121. This therefore if you take from 136 days, there remains the Current day of *May*, *viz.* The 15 d. 21 h. 45 min. 56. sec. upon which we suspect an Eclipse of the Moon may happen. But now whether it will certainly be or no, and whether it will appear in our Horizon, will be then manifest, when we have found out the time of the true Full Moon by the following Problem.

Months complete.	*Days collected into* A Common Year.	*Days collected into* Leap-Year.
January	31	31
February	59	60
March	90	91
April	120	121
May	151	152
June	181	182
July	212	213
August	243	244
September	273	274
October	304	305
November	334	335
December	365	366

But if you farther desire to know the time of the other Eclipse of the Moon, that will be seen the same year, (if the true Motions will allow of it,) you must add to the time just now gather'd, the time of 5 or 6 Lunar Months, and to the Motion of Latitude, the Motion that answers so many Months; so that the Motion that is made up of both, may at length be within the Bounds of Eclipsing.

	D.	ho.	min.	sec.	Moons Mot. of Lat. Sig.	deg.	min.	sec.
The time of the first Eclipse of ☽	136	21	45	56	06	05	46	29
The time of 6 Months ☽	177	04	24	19	06	04	01	23
	314	02	10	15	00	09	47	52

There then appears the Current day from the beginning of the year, *viz.* 314 d. 2 h. 10 m. 15 sec. which day, according to the little Table fore-going, falls in with the *9th* of *Novemb.* Current 2 ho. 10. min. 15 sec. And the Moon's Motion of Latitude, *viz.* 0 sig. 9 deg. 47. min. 52 sec. is within the bounds of Eclipsing; wherefore

I conclude, that on that day an Eclipse of the Moon may happen, if the true Motions agree to it.

And we may also seek for the Eclipses of the Sun the same way. For if from the time of the first Full-Moon, which happens *Jan.* 18 d. 18 h. 49 min. 43 sec. you take the time of half a Lunar Month; you shall have the very minute of the first middle New-Moon.

	D. ho. mi. sec.	The Moon's Mot. of Lat. Sig.	deg.	min.	sec.
Jan.	18 18 46 43	02	03	05	33
Half Month	14 18 22 02	06	15	20	07
Jan.	04 00 27 41	07	17	45	26

The first New Moon of the Year 1668 is *Jan.* 4 d. 0 h. 27 min. 41 sec. and the Motion of the Moon's Latitude is 7 sig. 17. deg. 45 min. 26 sec. which because it is out of the Bounds of Eclipsing, it is to be taken from the Bounds that next follow, of which that on this side is 11 sig. 18 deg. 38 min. and that beyond is 0 sig. 20 deg. 41 min.

Sig.	deg.	min.	sec.	Sig.	deg.	min.	sec.
11	18	38	00	00	20	41	00
07	17	45	26	07	17	45	26
04	00	52	34	05	02	55	34

Then in Table the XVII. under the Motion of the Moon's Latitude, let the number be sought for, that is between these two last; which is found to be 4 sig. 2 deg. 40. min. 56 sec. which agrees with 4 Lunar Months. Therefore now to the

	D.	ho.	min.	sec.	The Moon's Mot. of Lat. Sig.	deg.	min.	sec.
Time of the first Full Moon	4	00	27	41	07	17	45	26
Add the time of 4 Months	118	02	56	13	04	02	40	56
	122	33	23	54	11	20	26	22

Then appears the current Day from the beginning of the year, *viz.* 122, which, according to the foregoing little Table, falls in with *May* the 1 d. 3 h. 23 min. 54 sec. And the Moon's Motion of Latitude 11 sig. 20 deg. 26 min. 22 sec. is within the Bounds of Eclipsing. Wherefore we say, on the first of *May* an Eclipse of the Sun may happen. Then 6 Lunar Months being added, there is found the time of another Solar Eclipse.

	D.	ho.	min.	sec.	The Moon's Motion of Lat. Sig.	deg.	min	sec.
The time of the first Eclipse of the Sun	122	03	23	54	11	28	26	22
6 Lunar Months	177	04	24	19	06	04	01	23
	299	07	48	13	05	24	27	45

So the Current day from the beginning of the year appears to be the 299th, that is, *Octob.* 25 d. 7 h. 48 min. 13 sec. At which time the Motion of the Moon's Latitude 5 sig. 24 deg. 27 min. 45 sec. falls within the Bounds of Eclipsing, wherefore upon that day perhaps an Eclipse of the Sun may be seen.

PRO-

PROBLEM VI.

To find the time of the true Syzygy.

WE must first have found by Problem IV the time of the middle Syzygy, together with the middle Motions that agree with the same time. And when the Syzygy is not liable to have an Eclipse in it, or we are not solicitous to examine an Eclipse throughly, then the Motions of the Sun's and Moon's Anamoly are sufficient: But when we have a mind to enquire into the Quantity, Duration, Beginning and Ending of an Eclipse, we must take in also the Motion of the Moon's Latitude, and the Motion of the Sun from *Aries*. Let us now re-assume the Example us'd in the Problem, where it was found, that the first middle New-Moon of the year 1656 was *Jan.* 1 d. 17 ho. 25 min. 54. sec. and at the same time

	Sig.	*deg.*	*min.*	*sec.*
The Anomaly of the Sun	00	14	29	40
of the Moon	05	13	03	26
The Moon's Mot. of Lat.	05	23	11	03
The Mot. of the Sun from *Aries*	09	20	50	41

Now 'tis here apparent, that the Moon's Mot. of Lat. 5 sig. 23 deg. 11 min. 3 sec. falls within the Bounds of Eclipsing, whence we suppose that an Eclipse of the Moon may happen. But that we may be more certain of this, we must now inquire into the exact time of the true Syzygy. With the Anomaly of the Sun 6 sig. 14 deg. 29 min. 40 sec. take out of the XI Table the *Prosthaphæresis* of the Sun, 31 min. 57 sec. A. And with the Anomaly of the Moon by the same Table is found the Moon's *Prosthaphæresis*, 1 deg. 29. min. 55. sec. S. And seeing the *Prosthaphæreses* are of a different kind, the one to be added, and the other to be subtracted, the summ of them affords the Distance of the Luminaries 2 deg. 1 min. 52. sec. But if they were either both to be added, or both to be subtracted, then the difference of the *Prosthaphæreses* would give the Distance of the Luminaries. And now with the distance of the Luminaries just now found, 2 deg. 1 min. 52 sec. go to Table X, which is the Moon's Hour Table: And under the Title of the Longitude of the Moon from the Sun, seek for the number, that next of all agrees with that number, and there you will find 2 deg. 1 min. 54 sec. and over against it in the first Column 4 hours, whence it is manifest, that the Moon may in the next 4 hours exceed in her middle motion that space she is distant from the Sun at the time of the middle Full-Moon. And therefore there is almost the same space of time between the middle and the true Syzygy, and it is call'd the *Prosthaphæretical* Time, because it is wont sometimes to be added to, sometimes to be taken from, the Time of the middle Syzygy, according as the Moon at the time of the middle Syzygy has either as yet not overtaken the Sun, or is past by it. Which thing is not hard to be gather'd from the Nature of the *Prosthaphæreses*: For seeing at the time of the middle Syzygy the Lines of the middle Motions of the Sun and Moon are join'd, the *Prosthaphæreses* shew how much the Lines of the true Motions do decline from them: And the Tittle of the *Prosthaphæreses*, (Add, or Subtract,) shews whether the Luminary be behind or before them. In our Example the *Prosthaphæresis* of the Sun is to be added; therefore the Sun is beyond the Lines of middle motion, that is, in the following Signs; and the Moon's *Prosthaphæresis* being to be subtracted, argues it to be on this side, or in the Antecedent Signs. Therefore the Moon has not yet overtaken the Sun by its true Motion, and the true Syzygy follows the middle one almost 4 hours. And the same also holds true, when the *Prosthaphæresis* of the Sun and Moon are both of them to be added, and the Sun's is the greater; or when they are both to be subtracted, and the Sun's is the less. For in every of these Cases the Moon is on this side the Sun. But on the contrary the true Syzygy goes before the middle one, when the *Prosthaphæresis* of the Sun is to be subtracted, and the Moon's to be added; or when the *Prosthaphæreses* of the Sun and Moon are either both to be added, and the Moon's is the greater, or else both to be subtract-

ed,

ed, and the Moon's is the less. For in each of these Cases the Moon is gone beyond the Sun. Now though by this first way of working the *Prosthaphæretical* Time be found to be about four hours, yet if the Computation be repeated twice and again, it will be found, that 20 Minutes are to be taken from that Summ of four hours, which I thus find out. To the *Prosthaphæretical* time of four hours does answer (in Tab. V. which is the Sun's Hour-Table) the Anomaly of the Sun 9 Min. 51 Sec. and to the same *Prosthaphæretical* Time does agree (in Tab. X which is the Moon's Hour-Table) the Anomaly of the Moon 2 Deg. 10 Min. 39 Sec. Now let these Portions be added every one to its own Anomaly, that is before found; let them be added, I say, because the true *Syzygy* follows.

	The Anomaly of the Sun.				*The Anomaly of the* Moon.			
	Sig.	*Deg.*	*Min.*	*Sec.*	*Sig.*	*Deg.*	*Min.*	*Sec.*
At the time of the middle Full Moon	00	14	29	40	05	13	03	26
For the *Prosthaphæretical* time of 4 hours	00	00	09	51	00	02	10	39
The time of almost the true Full Moon.	06	14	39	31	05	15	14	05

And to these Anomalies do now answer the *Prosthaphæreses* out of the XI Table, the Sun's of 32 Min. 18 Sec. A. and the Moon's of 1 Deg. 18 Min. 25 Sec. S. Wherefore the distance of the Lines of the middle Motion of 1 Deg. 50 Min. 43 Sec. And farther in the Tab. X. the Longitude of the Moon from the Sun, that is next of all less, is 1 Deg. 31 Min. 26 Seconds, answering to three hours.

	Deg.	*Min.*	*Sec.*	
The distance of the Lines of middle Motion	01	50	43	Subt.
The Long. of the Moon from the Sun next of all less	01	31	26	
The Remainder is	00	19	17	

To these remaining 19 Min. 17 Sec. that are found in the same Table under the Title of the Longitude of the Moon from the Sun, do answer next of all 38 Min. Therefore the truer *Prosthaphæretical* Time is 3 Hours 38 Minutes. Now why we think this *Prosthaphæretical* Time of 3 Hours 38 Min. to be truer, than that which was first found, *viz.* of four hours, it will be worth our while to know. For although at the Time of the middle *Syzygy*, the Lines of the true Motions of the Sun and Moon are distant exactly 2 Deg. 1 Min. 52 Sec. as was found above; and also four hours after, when the Lines of the true Motions are almost joyn'd, the Lines of the middle Motions are almost distant, as much as these *Prosthaphæreses* did just now intimate, *viz.* 1 Deg. 50 Min. 43 Sec. Yet if we consider, that when we did at first seek the *Prosthaphæretical* Time, we us'd the middle Motion of the Moon's Longitude from the Sun, or the equable Motion, which we were forc'd to doe; because the Progress of the true Lines is inconstant, and changes every Moment; wherefore it is no wonder, if the Lines of the true Motions (though they be really distant 2 Deg. 1 Min. 52 Sec.) yet do not get over the space of that distance in four hours, as the Lines of the true Motions would indeed do, if they were so far distant. But now on the contrary, at the time of the true *Syzygy*, when the Lines of the true Motions are joyn'd, the Lines of the middle Motions are altogether distant, as much as the *Prosthaphæreses* declare, *viz.* 1 Deg. 50 Min. 43 Sec. and when the Lines of the middle Motions go on equally, and according to the numbers express'd in Tab. X. it is plain, that they will pass over as much space of Distance, *viz.* 1 Deg. 50 Min. 43 Sec. in altogether as much space of Time, *viz.* in 3 Hours 38 Min. and so will come to be joyn'd together; that is, between the time of the joyning of the Lines of middle Motion, and the meeting of the Lines of the true Motion there must be 3 Hours, 38 Min. And this would plainly happen, if the Lines of the true Motions were then exactly joyn'd, when the Anomalies and *Prosthaphæreses* were such as we have now made use of. But because they are even then distant some little space, it is necessary to use a third way of working it. For we know, that the more exact space between the middle *Syzygy* and the true is 3 Hours, 38 Min. in which space the Anomaly of the Sun goes on 8 Min. 57 Sec. and the Anomaly of the Moon 1 Deg. 58 Min. 40 Sec. which Portions

ons are again to be added to the Anomalies that were first of all found.

	The Anomaly of the Sun.				The Anomaly of the Moon.			
	Sig.	Deg.	Min.	Sec.	Sig.	Deg.	Min.	Sec.
At the time of the middle full Moon	06	14	29	40	05	13	03	26
For the *Prosthaph.* Time of 3 h. 38′	00	00	08	57	00	01	58	40
At the time of the true Full Moon	06	14	38	37	05	15	02	06

And to these Anomalies do answer the *Prosthaphæreses* out of Tab. XI. that of the Sun's is 32 Min. 32 Sec. A. but that of the Moon 2 Deg. 19 Min. 27 Sec. S. Wherefore

	Deg.	Min.	Sec.	
The Distance of the Lines of middle Motion	01	51	59	Subtr.
Then out of Tab. X. the next less Number	01	31	26	
	00	20	33	

And to this next less Number, *viz.* of 1 Deg. 31 Min. 26 Sec. do answer in Tab. X. three hours, and to the remaining 20 Min. 33 Sec. do there agree 40 Min. Wherefore the *Prosthaphæretical* Time, which is accurate enough, is 3 Hours 40 Min.

To which Answers out of Tab. V. 9 Min. 2 Sec. and out of Tab. X. the Anomaly of the Moon 1 Deg. 59 Min. 45 Seconds.

	The Anomaly of the Sun.				The Anomaly of the Moon.			
	Sig.	Deg.	Min.	Sec.	Sig.	Deg.	Min.	Sec.
At the Time of the middle Full Moon	06	14	29	40	05	13	03	26
For the *Prosth.* Time 3 h. 40′	00	00	09	02	00	01	59	45
At the time of the true Full Moon	06	14	38	42	05	15	03	11

And now to these Anomalies do answer the *Prosthaphæreses* out of Tab. XI. that of the Sun is 32 Min. 15 Sec. A. but that of the Moon 1 Deg. 19. Min. 22 Seconds. S. Wherefore

The Distance of the Lines of middle Motion is	01	51	37	Subt.
Then out of Tab. X. the next less Number	01	31	26	
	00	20	11	

To this next less Number, *viz.* of 1 Deg. 31 Min. 26 Sec. do answer Tab. X. three hours; and to these remaining 20 Min. 11 Sec. do there agree 39 Min. 43 Seconds. Wherefore the most exact *Prosthaphæretical* Time of all is 3 h. 39 Min. 43 Sec. which is to be added, because the Moon is on this side the Sun; Therefore to the

	D.	H.	M.	Sec.
Time of the middle Full Moon, *Jan.*	01	17	25	54
Add the *Prosthaph.* Time	00	03	39	43
The most exact Time of the true Full Moon, *Jan.*	01	21	05	37

For the finding the true Place of the Sun.

	Sig.	Deg.	Min.	Sec.	
At the time of the mid. Full Moon, the mid. Mot. of ☉ from ♈	09	20	50	41	
The Motion of the Sun for the *Prosth.* Time	00	00	09	01	
The *Prosthaphæresis* of the Sun	00	00	32	15	A.
The true Place of the Sun at the time of the true Full Moon	09	21	31	57	

With this true Place of the Sun the Table of the Equation of Time, inserted page 785. is to be gone to; where you shall find the Equation of Time, that answers the said Place of the Sun, to be 7 Min. 0 Sec. which are to be subtracted, because in this

this Place the Astronomical Time is to be turn'd into Apparent. Now therefore from the

	D.	H.	M.	Sec.	
Time of the true Full Moon, *Jan.*	01	21	05	37	
Take the Equation of Time	00	00	07	00	
The Time apparent of the true Full Moon, *Jan.*	01	20	58	37	After
Mid-night, or *Jan.*	01	08	58	37	After
Mid-day, or, according to the *Gregorian* Account, *Jan.*	00	08	58	37	After
Mid-day in *Friesland.*					

PROBLEM VII.

To prove the Time of the true Syzygy, *found by the foregoing Prob. out of the Solar and Lunar Tables.*

BEcause the *Epochæ* of the *Lunæ-Solar* Tables are fitted to the Meridian of *Friesland*, but the *Epochæ* of the Solar and Lunar Tables do suit with the Meridian of *Urenburgh*; therefore the apparent Time given from *Frisian* Meridian is first to be reduc'd to that of *Urenburgh*, by adding 25 Minutes of an hour; because the Meridian of *Urenburgh* is more Eastward than that of *Friesland*; therefore

	D.	H.	M.	Sec.
To the apparent Time of the true Full Moon in *Friesland*, *Jan.*	01	08	58	37
Add the Difference of the Meridians	00	00	25	00
The apparent Time of the true Full Moon in *Denmark*, *Jan.*	01	09	23	37

Then the apparent Time is to be turn'd into Astronomical, and that after one way for the Sun, and after another way for the Moon; as I have taught Prob. I. of this Section, Paragraph 2. And for the Sun thus; with the true Place of the Sun ♑ 21 Deg. 31 Min. 57 Sec. Page 785. I take the first part of the Equation of Time, *viz.* 7 Min. 0 Sec. to be added. Then afterwards with the middle Anomaly of the Sun 6 Sig. 14 Deg. 38 Min. 42 Sec. I go to the other part of the Equation of Time, Page 785. which I there find to be 2 Min. 3 Sec. which are likewise to be added. And so the whole Equation of Time becomes 9 Min. 3 Sec. to be added. Hence I always take 7 Min. 53 Sec. according to what was admonish'd in the first Prob. and there remains the Equation of Time for the Sun, 1 Min. 10 Sec. A. Now therefore to

	D.	H.	M.	Sec.
The apparent Time of the true Full Moon, *Jan.*	01	09	23	37
Add the Equation of Time for the Sun	00	00	01	10
And there is made the Astronomical Time for the Sun	01	09	24	47

To which Time I gather, by Prob. II. the middle Motion of the Sun from *Aries*, 9 Sig. 20 Deg. 59 Min. 28. Sec. The middle Anomaly of the Sun, 6 Sig. 14 Deg. 38 Min. 28 Sec. and the *Prosthaphæresis* of the Sun, that agrees with this, 32 Min. 15 Sec. A. Wherefore the true Place of the Sun is 9 Sig. 21 Deg. 31 Min. 43 Sec.

The Time is likewise to be equall'd for the Moon, according to the Admonition in the first Prob. Namely, by applying only the first part of the Equation of Time, which was 7 Min. 0 Sec. A. Wherefore

	D.	H.	M.	Sec.
To the apparent Time of the true Full Moon, *Jan.*	01	09	23	37
Add the Equation of Time for the Moon	00	00	07	00
There appears the Astronomical Time for the Moon, *Jan.*	01	09	30	37

And

And to this Time I gather by Prob III. out of the Lunar Tables, the Longitude of the Moon from the Sun, 6 Sig. 1 Deg. 51 Min. 36 Sec. The middle Anomaly of the Moon 5 Sig. 15 Deg. 3 Min. 1 Sec. and the Motion of the Moon's Latitude 5 Sig. 25 Deg. 12 Min 10 Sec. Then the *Prosthaphæresis* of the Moon 1 Deg. 19 Min. 22 Sec. A. which agrees with the Anomaly collected. And then afterwards

	Sig.	*Deg.*	*Min.*	*Sec.*
To the middle Motion of the Sun from the *Æquinox*	09	20	59	28
I add the Longitude of the Moon from the Sun	06	01	51	36
And there appears the mid. Mot. of the Moon from the *Æquin.*	03	22	51	04
To which I apply the Moon's *Prosthaph.*	00	01	19	22 S.
There then comes the Moon's true Place in its Orb.	03	21	31	42
And the true Place of the Sun above was	09	21	31	43
Wherefore the true Distance of the Moon from the Sun	05	29	59	59

Whence it is manifest, that the time of the true Full Moon was rightly found, which was the thing that was to be prov'd.

PROBLEM VIII.

To find the Latitude of the Moon.

	Sig.	*Deg.*	*Min.*	*Sec.*
BY the foregoing Problem was found the Moon's middle Motion	05	25	12	10
And the *Prosthaphæresis* of the Moon	00	01	19	22 S.
Therefore the true Motion of the Moon's Latitude is	05	23	52	48

And now entring with this Motion of Latitude Tab. XX. which is the Table of the Moon's Latitude, I find the Latitude of the Moon to be 31 Min. 46. Sec. *North*.

And this is the Method of finding the Moon's Latitude in the true *Syzygies*; but out of the *Syzygies* the middle Motion of Latitude is twice to be equall'd, as in the Example of Prob. III. *viz.* in the Year 1587. *August* 18. the middle Motion of Latitude was 9 Sig. 0 Deg. 57 Min. 19 Sec. the absolute *Prosthaph.* was 4 Deg. 40 Min. 12 Sec. to be taken away: Therefore the Motion of Latitude first equall'd was 8 Sig. 26 Deg. 17 Min. 7 Sec.

But now that this same may be equall'd a second time, entring with the true Distance of the Luminaries XIX. which is the Tab. of the Equation of the Nodes of the Moon, I take from thence the Equation of the Nodes, together with the proportional Scruples: And reserving the Minutes for another use, you must add or take the *Prosthaph.* found to or from the Motion of Latitude first equall'd, that there may come out of the Motion equated a second time. As in the Example mentioned in the Year 1587. *Aug.* 18. the almost true Distance of the Luminaries was 9 Sig. 23 Deg. 29 Min. 7 Sec. the exactly true Distance, 9 Sig. 22 Deg. 18 Min. with which, when I go to the Table of the Equation of the Nodes, I meet with a *Prosthaph.* of 1 Deg. 12 Min. 57 Sec. subt. and of proportional Scruples 51. and 34 Seconds.

	Sig.	*Deg.*	*Min.*	*Sec.*
The Motion of Latitude first equated	08	26	17	07
The *Prosthaph.* to be taken away	00	01	12	57
The Mot. of Lat. a second time equated	00	25	04	10

From which you may thus gather the true Latitude of the Moon.

With the Motion of Latitude a second time equall'd you must go to the Table of Latitude, as here with 8 sig. 25 deg. 4 min. the Latitude that answers this Motion is this, 4 deg. 57 min. 24 sec. South; to which is adjoin'd the Excess of 18 min. 55 sec. for which you may safely take 19 min. Some part of this Excess is always to be added to the Latitude that's found; I mean the Part that answers in proportion to the proportional Scruples, which are reserv'd for this use: For thus you must say, 60 Scruples add 19 min. how much will 51 ½ add? Suppose 16 min. 18 sec. which being added to the Latitude that's found, the Summ will be the true Latitude of the Moon, *viz.* 5 deg. 13 min. 42 sec. which was what we sought for.

PROBLEM IX.

To compute the Beginning, Middle, and End of an Eclipse of the Moon; as also the quantity of an Obscuration.

BY the sixth Problem was found the Apparent Time of the true Full Moon in *Friseland*, *viz. Jan.* 1d. 8h. 58 min. 37 sec. after Mid-day; and by the eighth Problem the Latitude of the Moon at that very moment of time was found to be 31 min. 46 sec. North. Lastly, By the seventh Problem was gather'd at the same time the middle Anomaly of the Sun, 6 sig. 14 deg. 38 min. 28 sec. and the middle Anomaly of the Moon 5 sig. 15 deg. 3 min. 1 sec. and the *Prosthaphæresis* of the Moon that agrees with this, 1 deg. 19 min. 22 sec. S. which if it be applied to the middle Anomaly, the Co-equalled Anomaly of the Moon becomes 5 sig. 13 deg. 43 min. 39 sec. And now being thus furnished with these things, we proceed to the Thing that's to be done. And first entering with the Moon's Co-equalled Anomaly of 5 sig. 13 deg. 43 min. 39 sec. Table XXIII. which is the Table of the apparent Semi-diametres of the Sun, Moon, and the Earth's Shadow, I take out the Semidiametre of the Full Moon 17 min. 57 sec. and also the Semi-diametre of the Shadow 46 min. 51 sec. Again, with the middle Anomaly of the Sun, 6 sig. 14 deg. 38 min. 28 sec. I take out of the same Table the Variation of the Shadow, 56 sec. which is always taken from the Semi-diametre of the Shadow, that the same may remain corrected, *viz.* 45 min. 55 sec. To this we add the Semi-diametre of the Moon: And the Summ of the Semi-diametres of the Shadow and of the Moon becomes 63 min. 52 sec. And so we may at length safely pronounce, whether the Moon will suffer any Eclipse or no. For if at the time of the true Full Moon the Moon's Latitude be less than that Summ of the Semi-diametres of the Shadow, and of the Moon; then you may certainly know, that there will be an Eclipse of the Moon, otherwise there will be none. But now in our Example the Moon's Latitude is of 31 min. 46 sec. North, which is much less than the Summ of the Semi-diametres, 63 min. 52 sec. Therefore the Moon will certainly fall under the Shadow of the Earth.

Look now upon Figure XLVI, as if being plac'd on the Earth, you should look towards the Ecliptick ☋ *u*, and the Orbit of the Moon ☋ *c*; and let ☋ mark the Descendent Node of the Moon, *u* the Centre of the Earth's Shadow, *l* the Moon, as far distant from the Node ☋ as *u* is, namely, at that we have said, the true Full Moons happens. For you must here note three points in the Orbit of the Moon, to wit, C, L, S; and let *c u* and L *r* be perpendicular to the Ecliptick ☋ *u*. Therefore if we speak of the time, at which the Moon is join'd with the Shadow according to her Longitude taken in the Ecliptick; then C is the point, in which the Moon must then be. But we shall take no notice of that moment of time, because it makes nothing to our present purpose: For that time of the true Full Moon, which we found by the sixth Problem, and repeated at the beginning of this, agrees with the Moon, when in L, and when distant as much from ☋, as the shadow *u*: And then the Latitude of the Moon is L *r*; but the greatest Obscuration or Immersion of the Moon into the Shadow does not then happen, when the Moon is in L, but when it is gone on to the point S, where a perpendicular from *u* does fall upon the Orbit And then the shortest Distance of the Moon from the shadow, that is S *u*, is equal to the Latitude L *r*, which the Moon had in *L*: but the Time of the greatest Obscuration follows the Conjunction

at

at so great a distance of time, as is necessary for the Moon in her true Motion to go thorough the Arch L S, which is equal to the Arch *r u*. And both of the Arches are the Difference between ♑ L the *Hypotenusa*, and ♑ *r* the greater Leg of the Rectangular Sphærical Triangle ♑ L *r*. For now in this Triangle ♑ L *r* are given besides the Right Angle at *r*, 1. The Angle ♑, which in every true *Syzygy* is of 4 deg. 58 min. 30 sec. 2. The *Hypotenusa* ♑ L of 6 deg. 7 min. 12 sec. to wit, the Complement of the true Motion of Latitude, which by the eighth Problem was found to be of 5 sig. 23 deg. 52 min. 48 sec. Now there is sought, 1. The Angle ♑ L *r*, to which ♑ *u* S is equal, namely, which the Perpendicular from the Shadow to the Orbit does make with the Ecliptick, and it is of 85 deg. 3 min. 2. The Leg ♑ *r* of 6 deg 5 min. 50 sec. Therefore the difference between ♑ L and ♑ *r* is 1 min. 22 sec. which is the Arch LS. Then afterwards we are to seek in how much time the Moon will go through this Arch L S by its true Motion. Therefore with the Co-equated Anomaly of the Moon 5 sig. 13 deg. 43 min. 39 sec. go to the XXIV Table, where you shall find the Horary Motion of the Moon in it's true *Syzygies* to be 33 min. 16 sec. Wherefore you must say by the Rule of Three: If 33 min. 16 sec. give one hour, or 3600 sec. what will 1 min. 22 sec. give? There appear 2 min. 28 sec. which is the space of Time, in which the greatest Obscuration follows the Conjunction in the Orbit. But the Apparent time of the true Conjunction in the Orbit, under the *Meridian* of *Friseland*, was *Jan.* 1 d. 8 ho. 58 min. 37 sec. and then adding 2 min. 28 sec. there is made up the Time of the greatest Obscuration 1 d. 9 h. 1 min. 5 sec. in *Friseland*. Now the difference of the *Parisian* and *Frisian Meridians* by Tab. XLVII is 16 m. For *Paris* is distant from *Urenburgh* Westward 41 min. and from *Leoward* in *Frieseland* 25. Wherefore *Paris* is 16 min. more Westward: And so there being taken out of the Time just now gather'd, 16 min. the Apparent time of the greatest Obscuration is at *Paris*, *Jan.* 11 d. 8 ho. 45 min. 5 sec. after Mid-day, after the *Gregorian* Account.

It remains now, that I define the Beginning and Ending, and also the Quantity of the Obscuration. Now therefore in the XLVII Figure, let *a* be the Centre of the Shadow, *b a c* the Ecliptick; let the Angle *b a e* be of 85 deg. 3 min. equal to the Angle ♑ L *r* or ♑ *u* S in the foregoing Figure; Let *a e* be the distance of the Moon from the Centre of the Shadow at the time of the greatest Obscuration, and let it be suppos'd equal to the Latitude L *r* in the precedent Figure, being 31 min. 46 sec. and let *f e d* the Perpendicular to *a e* represent the Orbit of the Moon: Let *a g* be the Correct Semidiametre of the Shadow of 45 min. 55 sec. *g d* the Semidiametre of the Moon of 17 m. 57 sec. *a d* the Summ of the Semidiametre of the Moon and of the Shadow 63 min. 52 sec. In the plain Triangle *a e d*, there is given the *Hypotenusa* *a d* of 63 min. 52 sec. to the Right Angle at *e*, and the Leg *a e* of 31 min. 46 sec. The other Leg *d e* is sought by the XLVII Table and is found to be 55 min. 24 sec. which is the Line of the Moon's Course from the Beginning of the Eclipse to the middle of the Obscuration; to which is equal *e f*, the Line that is to be pass'd from the greatest Obscuration to the end. Then you must say by the Rule of Three: If 33 min. 16 sec. give one hour, or 3600 sec. what will 55 min. 24 sec. afford? There comes 1 h. 39 min. 55 sec. which is half the Duration.

	D. H. M. Sec.	
The Appar. Time of the greatest Obscuration at *Paris*, *Jan.*	11 08 45 05	} Add and
Half of the Duration	00 01 39 55	} Subtract.
The beginning of the Eclipse	11 07 05 10	
The End	11 10 25 00	
The whole Duration	00 03 19 50	

Lastly, for determining the Quantity of the Eclipse,

	Min.	Sec.
Take the Latitude of the Moon *a e*	31	46
From the Correct Semidiametre of the Shadow *a h*	45	55
There remains *e h*	14	09
To which add the Moon's Semid. *e i*	17	57
And there appears *i h* that part of the Moon's Diam. immens'd in the Shadow	32	06

Then say by the Rule of Three: The Semidiametre of the Moon *e i* amounts to 6 Digits; how much does *i h* = 32 min. 6 sec. amount to? And there come 10 Ecliptical Digits, and 44 Scruples; which is the quantity of the Eclipse that was enquir'd after.

PROBLEM X.

To give an Account of the Calculation of an Eclipse of the Sun.

THis Calculation is perform'd in two parts: by the former the time of the true Conjunction is sought, just the same way, that was us'd in a Lunar Eclipse; by the latter time of the seeming Conjunction, and also the Beginning and Ending, and likewise the Apparent Quantity of the Eclipse, are sought for, by the help of the *Parallaxes* of Longitude and Latitude. We will take for an Example the Eclipse of the Sun, that happen'd in the year 1656, being Leap-year, *Jan.* the 16/26, current Day in the Afternoon. The Calculatio of it out of *Tycho's* Tables, with respect to the *Parisian* Horizon runs thus:

	D. H. M. Sec.
The middle New Moon *Jan.*	16 11 47 55 after Midnight.
	Sig. Deg. M. Sec.
The Anomaly of ☉	06 29 02 50
The Anomaly of ☽	11 25 57 56
The Motion of the Moon's Latitude	00 09 20 33
The Motion of ☉ from ♈	10 05 23 53
The *Prosthaph.* of ☉	00 01 01 45 A.
The *Prosthaph.* of ☽	00 00 20 29 A.
The Distance of the Luminaries	00 00 41 06
The *Prosthaphæretical* Time of hours	— 01 21 00 A.

To which does Answer

	Min. Sec.
The Anomaly of ☉	03 19
The Anomaly of ☽	44 06

Therefore at the time of almost the true New Moon

	Sig.	*Deg.*	*Min.*	*Sec.*
The Anomaly of ☉ is	06	29	06	09
The Anomaly of ☽ is	11	26	42	02

		Deg.	*Min.*	*Sec.*
The *Prosthaph.* of ☉		01	01	52 A.
The *Prosthaph.* of ☽		00	16	43 A.
The distance of the Lines of middle Motion		00	45	09
The Horary *Prosthaph.* Time		—	01	29 A.

To which Answers

	Min.	*Sec.*
The Anomaly of ☉	03	39
The Anomaly of ☽	48	27

Therefore at the time of the true New Moon,

	Sig.	*Deg.*	*Min.*	*Sec.*
The Anomaly of the Sun is	06	29	06	29
The Anomaly of the Moon is	11	26	26	23

The

	Sig.	Deg.	Min.	Sec.	
The *Prosthaphæreses* of the Sun	00	01	01	52	A.
The *Prosthaphæreses* of the Moon	00	00	16	21	A.
The distance of the lines of Middle Motion	00	00	45	31	
The most exact Horary *Prosthaphæretical* Time.		01	29	37	

To which answers

	Min.	sec.
The Anomaly of the Moon.	48	47
The Moon's Motion of Latitude.	49	24

Therefore at the most exact time of the true New Moon.

	Sig	Deg.	Min.	Sec.	
The Simple Anomaly of the Moon is	11	26	46	43	α
The middle Motion of Latitude is	00	09	20	34	β

The most exact time of the true New Moon is,

	Da.	Ho.	Min.	Sec.	
Jan. current,	16	13	17	32	
		Deg.	Min.	Sec.	
The true place of the Sun in ♒		06	29	14	
The Equation of time		00	09	37	S.
	Da.	Ho.	Min.	Sec.	
The Apparent time of the true N. M. *Jan.*	16	13	07	55	aft. Midnight
or *Jan.*	16	01	07	55	aft. Mid-day.
Or according to the *Gregorian* Account. in *Friseland.* } *Jan.*	26	01	7	55	aft Mid-day.

The Examination of this out of the *Solar* and *Lunar* Tables.

		Da.	Ho.	Min.	Sec.	
The Apparent time of the true New Moon in *Friseland*, is }	*Jan.*	16	01	07	55	after Mid-day.
The difference of the Meridians of *Friseland* and *Denmark* }		00	00	25	00	A.
The Apparent time of the true New Moon in *Denmark*, is }	*Jan.*	16	01	32	55	

	Min.	Sec.	
The first part of the Equation of time.	09	37	A.
The latter part.	03	56	A.
The absolute Equation of time.	13	33	A.

	Min.	Sec.	
There being then cast away	07	53	according to what's said in Problem I.
There rests the Equation of time for the Sun. }	05	40	A.

	Da.	Ho.	Min.	Sec.	
Therefore the equable time, of the Sun is *Jan.*	16	01	38	35	after Mid-day.
or the day being compleat, *January*	15	01	38	35	after Mid-day.

	Min.	Sec.	
Then the Equation of time for the Moon is	09	37	A.

	Da.	Ho.	Min.	Sec.	
Wherefore the equable time for the Moon, is *Jan.*	16	01	42	32	after Mid-day.
or the day being compleat, *January*	15	01	42	32	after Mid-day.

The

	Sig.	Deg.	Min.	Sec.	
The Motion of the Sun from ♈.	10	05	27	23	
The Anomaly of the Sun	06	29	06	24	
The *Prosthaphæreses* of the Sun	00	01	01	52	A.
The true place of the Sun	10	06	29	15	
The Longitude of the Moon from the Sun	00	00	45	31	
The Anomaly of the Moon (α)	11	26	46	41	
The Motion of the Moon's Latitude, (β)	00	09	20	33	
The *Prosthaphæreses* of the Moon	00	00	16	19	A.
The middle distance of the Moon from ♈.	10	06	12	54	
The true place of the Moon in the Zodiack	10	06	29	13	
The true place of the Sun	10	06	29	15	
The true distance of the Moon from the Sun.	11	29	59	58	

Thus far the Exmination, and the first part of the Calculation.

The other part of the Calculation belongs to the time of the Apparent Conjunction, and also to the beginning and ending, and the Apparent quantity of the Eclipse, as it is seen at *Paris* from off the Surface of the Earth; for the true Conjunction, of which we have hitherto spoken, has respect to the Centre of the Earth. Now the Apparent time of the true New Moon, under the *Frisian* Meridian was, N. St.

		Da.	Ho.	Min.	Sec.	
	Jan.	26	01	07	55	aft. Mid-day.
The difference of the *Frisian* and *Parsian* Meridian,		00	00	16	00	S.
The Apparent time of the true New Moon at *Paris*.	*Jan.*	26	00	51	55	aft. Mid-day.

At which time you must find the Parallax of the Moon above the Sun as to Altitude and Longitude. In the XLVIII Figure, let A be the Zenith, A E D the *Parisian* Meridian, ♈ E F the Æquinoctial, ♈ D B K the Eccliptick, B the place of the true Conjunction of the Sun and Moon, as it would be seen from the Centre of the Earth, if the Eye was plac'd there; A F B I is the Vertical, passing down through the Sun and Moon, B I is the Parallax of the Moon above the Sun as to Altitude, B K the Parallax of Longitude, I K the Parallax of Latitude. In the little Triangle B I K, we must find out B I and B K; seeing therefore the Apparent time of the true Conjunction happens 51 Min. 55 Sec. after Noonday; this time being turn'd into degrees and Minutes, gives 12 Deg. 98 Min. which is the Arch E F. with the true place of the Sun, of ♒ 6 Deg. 29 Min. 15 Sec. Out of the XLVI Table is taken the Right Ascension of the Sun 308.89, which is the Point F, to which if you add the Arch E F, you will then find the Point of the *Æquator* that is plac'd under the Meridian 321.87, which is the Point E. To this point of the *Æquator* E does answer out of the same XLVI Table the Culminant point of the Ecliptick D, *viz.* 19 Deg. 26 Min. of ♒. The true place of the Moon, (the point B,) is 6 Deg. 29 Min. of ♒; therefore the Arch of the Ecliptick between the Meridian and the true place of the Moon, (*viz.* B D) is 12 Deg. 57 Min. To the point of the Ecliptick D, that is plac'd under the Meridian, does answer, according to the XLV Table, the Declination 15.03, which is the Arch D E; and there the Angle of the Ecliptick and of the Meridian ♈ D E = 71.72, whose complement 108.28 is the Angle A D B. Lastly, to the Arch D E = 15 03 add the Latitude of *Paris* E A = 48.50, and there comes the Arch D A = 63.53.

There being therefore given in the Triangle A D B, the two sides A D = 63.53, and D B = 12.95, with the Angle contain'd between them, A D B = 108.28; there is found A B, the distance of the Moon from the Zenith, to be 68.21, and the Angle A B D 66.28. The Complement of the Arch A B is the Altitude of the Moon 21.79. To the Anomaly of the Moon (α) 11 Sig. 27 Deg. does answer out of the XI Table, the Elongation of the Moon from the Centre 102.897. with this and the Latitude of the Moon is taken out of the XXI Table, the Parallax of the Altitude of the Moon 56 Min. and with the same Altitude of the Sun the Parallax

rallax of the Sun of 3 Min. Therefore the Parallax of the Moon above the Sun in 53 Min. which is B I the *Hypotenusa* of the little Triangle B I K: And in the same Triangle B I K, which is rectangular at B, there is given the Angle I B K, equal to the Angle A B D. And the Ttiangle B I K being taken (for its littleness) as plane, there is found B K the Parallax of Longitude = 21 Min. 18 Sec.

With the Anomaly of the Moon 11 Sig. 27 Deg. is taken out of the XXIV Table, the Hourly Motion of the Moon above the Sun, 27 Deg. 44 Min. Therefore by the Golden Rule,

If the true Motion of the ☽ above ☉.	give miuntes of an hour.	What will the Parallax of Longit. give.	There come Min. of an hour.
$27\frac{3}{4}$	60	$21\frac{3}{10}$?	$45\frac{7}{10}$

Therefore the seeming Conjunction would follow the true $45\frac{7}{10}$ minutes of an hour, if the Apparent Motion of the Moon was equal to the true Motion; but because that does not appear, let the Parallax of Longitude be sought again, at the time which follows the true Conjunction $45\frac{7}{10}$ Minutes.

The point of the *Æquator* that is plac'd under the Meridian at the time of the true Conjunction, is 321.87.

The Intermediate time being turn'd into degrees, is 11.42. Add this to the former point of the *Æquator* that is plac'd under the Meridian at the time of the seeming Conjunction, 333.29, which is the point E, to which does answer the Culminant point of the Ecliptick ♓, 1 Deg 15 Min. which is the point D.

		Deg.	Min.	Sec.
The place of ☽ at the time of the true Conjunction.		♒ 06	29	00
The Motion of ☽ in the intermediate time		00	21	18
The place of the Moon at the time of the seeming Conjunction which is the Point B.	}	♒ 06	50	18
		Sig.	Deg.	Min.
From the Culminant point of the Ecliptick D.		11	01	15
Take the place of the Moon B.		10	06	50
There remains the Arch B D		00	24	25

To the Culminant point of the Ecliptick does answer the Declination 11.06, which is the Arch D E, and the Angle of the Ecliptick and Meridian.

♈ D E. ——— ——— ———	69	14
whose complement to the Semicircles A D B	110	86
To the Arch D E ——— ———	11	06
Add the Latitude of *Paris* E A ———	48	50
And there is made the Arch D A	59	56

In the Triangle A D B, there being given A D, D B, A D B, there is found A B the distance of the Moon from the *Zenith* 70° $\frac{1}{2}$, and the Angle A B D 58° $\frac{5}{6}$.

The compleat of the Arch A B is the Altitude of the Moon	19° $\frac{1}{2}$
With which, and the Elongation of the Moon is taken,	
The Parallax of the Moon, ——— ———	56 $\frac{1}{2}$.
The Parallax of the Sun, ——— ———	3
The Parallax of the Moon above the Sun ——— ——— which is the Arch B I.	53 $\frac{1}{2}$.

In the Triangle B I K, which is rectangular at K, there being given B I, and the Angle I B K equal to A D B = 58 $\frac{5}{6}$, there is found the Parallax of Longitude B K = 27' $\frac{2}{3}$. θ.

	Min.	Sec.
The first Parallax of Longitude, (η)	21	18
The latter Parallax of Longitude, (θ)	27	40
The difference of the Parallax,	06	22

Is

	Min.	Sec.
Is to be taken from the first Parallax, and there remains the Apparent Motion of the Moon in the space of the Intermediate time of 45 Min. 42 Sec. =	14	56

The Apparent Motion of the Moon,	gives	Minutes of an hour.	The first Paral. of Longitude,	gives	Minutes of an hour.
14′ 56″		45′ $\frac{7}{10}$	21′ $\frac{3}{10}$		65′ $\frac{3}{10}$

Therefore the seeming Conjunction follows the true Min. 65 $\frac{3}{10}$ I.

Let there be sought therefore the Parallax of Longitude and Latitude at the time, which follows the true Conjunction, Min. 65 $\frac{3}{10}$.

	Deg.	Min.
The point of the *Æquator* plac'd under the Meridian at the time of the true Conjunction,	321	87
To which add the Intermediate time turn'd into degrees,	15	35
The summ of this Addition shews the point of the *Æquator* that is plac'd under the Meridian at the time of the seeming Conjunction, which is the point E,	337	22
To which answers out of the XLVI Table, the point of the Ecliptick plac'd under the Meridian,	♓ 5	22
The true Motion of the Moon in the time that passes between the true and seeming Conjunction, is 30 Min. The place of ☾ at the time of the true Conjun. was	♒ 6	29
Therefore adding these 30 Min. there is made up the true place of the Sun at the time of the seeming Coniunction, which is the point B,	♒ 6	59
The Arch of the Ecliptick between the Meridian, and the true place of the Sun is D B,	28	23
To the Culminant point of the Ecliptick D, does answer the Declination D E 9.56, and the Angle of the Ecliptick, and Meridian ♈ D E 68.44, whose compl. to the Semicircle is the Angle A D B,	111	56
To the Declination of the Culminant point, that is, to the Arch D E,	9	56
Add the Latitude of *Paris*, E A,	48	50
And there is made the Arch A D	58	06
There being therefore given in the Triangle A D B, the two sides A D, and D B, with the Angle between them A D B, there is found A B the distance of the Moon from the *Zenith*,	71	51
And the Angle A B D	56	30
The Compl. of the Arch A B is the Altitude of the Moon,	18	49

With this and the Elongation of the Moon there is taken out,

The Parallax of the Moon	57′	
The Parallax of the Sun	3	
The Parallax of the Moon above the Sun.	54	BI

	Min.	Sec.	
In the Triangle B I K which is Rectangular at K, there is given B I, and I B K, the Angle equal to the Angle A D B; and there is found the Parallax of Longitude B K.	30	00	K
And the Parallax of Latitude I K.	44	56	

The Examination of the seeming Conjunction.

At the time of the seeming Conjunction, the true distance of the Moon from the Sun ought to be equal to the Parallax of the Longitude of the Moon above the Sun, that is, to the Line B K which was lastly found. Let therefore the true distance of the Moon from the Sun be sought by the Rule of three, thus:

Minutes

Minutes of an hour	gives	The true Motion of the Moon.	Minutes between the true and seeming ☌	give	The dist. of ☽ from ☉ at the time of the seeming ☌
60′		27′$\frac{3}{4}$	65′$\frac{3}{10}$		30′. 11″. μ

This distance of 30′ 11″ agrees with the Parallax of Longitude B K, which we had found above to be 30′. Therefore the difference of time, 65′$\frac{3}{10}$ between the true Conjunction and the seeming is right.

To this time that passes between the true and seeming Conjunction, *viz.* 65′$\frac{3}{10}$ does answer

	M.	S.
The Anomaly of the Moon	35	33
The Motion of the Moon's Latitude	36	00

Therefore at the time of the seeming Conjunction

	S.	D.	M.	S.
The simple Anomaly of the Moon is	11	27	22	16
The middle Motion of Latitude	00	09	56	34
The *Prosthaph.* of the Moon	00	00	13	19 A.
The true Motion of the Moon's Latitude	00	10	09	53

To which does Answer

	M.	S.
The true Latitude of the Moon	52	36 North.
The Parallax of Latitude I K	44	56
The seeming Latitude of the Moon	07	40 North *a d*
The Semidiametre of the Sun	15	55 *a e*
The Semidiametre of the New Moon	12	48 *d f*
The Summ of the Semidiametres	28	43 *a g*
The cover'd part of the Sun's Semidiametre	21	03 *i e*

Which amounts to 07 55′ Ecclipticial Dig.

In the Triangle *a d g* which is as good as Rect-angular at *d*, there being given *a d* and *a g*, there is found *g d*, the Line of the Moon's Course, from the beginning to the middle of the Eclipse, = 27 min. 40 sec. Let it now be enquir'd, in how long time the Moon goes through this Line, in her Apparent Motion. Fig. XLIX

	M.	S.
The Paral. of Long. at the time of the seem. Conj. (κ.)	30	00
The Paral. of Long. at the time of the true Conj. (κ.)	21	18
The difference of the Parallaxes is	08	42 A.
The time between the true and seeming Conjunction. (ι)	65	$\frac{3}{10}$

To which Answers

The true Motion of the Moon (μ)	30	12
Take hence the Differences of the Parallaxes (λ)	08	42
There rests the Apparent Motion of the Moon for 65′$\frac{3}{10}$	21	30

The Appar. Mot. of the Moon	gives	Minutes of an hour.	The Line from the beginning to the middle of the Ecclipse	gives	The time of Incidence.
21′$\frac{1}{2}$		65$\frac{3}{10}$	27$\frac{2}{3}$		84′

Lastly, let the Parallax of Longitude be sought, which is 1 ho. 20 min. after the seeming Conjunction.

The point of the *Æquator*, plac'd under the Meridian at the time of the seeming Conjunction, (ξ)	337	22	add
The Intermediate time 1 ho. 2 min. being turn'd into deg. makes		20	
The point of the *Æquator*, plac'd under the Meridian 80′ after the seeming Conjunction	357	22	

To which Answers

		D.	M.	
The point of the Eclipt. that is plac'd under the Meridian	♓	27	00	D.
The true place of the Moon ♒		7	36	B.

The

	D.	M.	
The Arch of the Ecliptick between the Meridian and the true place of the Moon,	49	24	BD
To the point of the Ecliptick D, which is plac'd under the Meridian does answer the Inclin.	1	20	DE
And the Angle of the Ecliptick and of the Meridian,	66	51	♈DE
Whose Complement is ———	113	49	ADB
The Latitude of *Paris*, ———	48	50	AE
AE + DE,	49	70	
In the Triangle ADB, there being given AD, DB, ADB, there is found the distance of the Moon from the *Zenith*,	79	03	AB
And the Angle ABD, ———	45	43	
The compl. of the Arch AB is the Altitude of ☽,	10	97	

With this and the Elongation of the Moon there, is taken out

	Min.	
The Parallax of the Moon, ———	58	
The Parallax of the Sun, ———	3	
The Parallax of the Moon above the Sun,	55	BI

In the Triangle BIK, which is rectangular at K, there is given BI and IBK, the Angle equal to ADB; and there is found the Parallax of Longitude 38 ;, BK ϖ: Wherefore proceed according to the Rule of Three just now deliver'd.

	Min.	Sec.	
The Parallax of Long. at the time of the seeming Conj. (κ)	30	00	
The Parallax of Long of 80′ after the seeming Conj. (ϖ)	38	36	
The difference of the Parallaxes is ———	8	36	Subtract
The true Motion of the Moon in the space of 80′. is	36	59	
The Apparent Motion of the Moon in the space of 80′. is	28	23	

The Appa. Mot. of the Moon	gives	Minutes of an hour.	The line from the middle to the end of the Eclipses	gives	The Time of Emersion.
28′ 23″		80′	27 ;		78′

	D.	H.	M.	S.	
The Apparent time of the true Conj. at *Paris*, *Jan.*	26	0	51	55	after Mid-day.
The time between the true and seeming Conjunction,		1	05	18	
The Apparent time of the seeming Conjunction,	26	1	57	13	after Mid-day.
The time of Insidence, ———		1	24		Subtract
The beginning of the Eclipse, *Jan.*	26	0	33	13	after Mid-day.
The time of Emersion, ———		1	18		
The end of the Eclipse, ———	26	3	15	13	after Mid-day.
The whole Duration in hours, ———		2	42		

It now remains, that I furnish you with certain Rules, how to find the Apparent Motion of the Moon from the Sun; by the Guidance of which Rules I have drawn up the fore-going Calculation, and by which we must regulate the same in other Eclipses afterwards. First of all then we must determine that Interval of Time, at which we have a mind to find the Apparent Motion of the Moon. That Interval either comes between the Moment of the true Conjunction, and that Instant, at which the Moon in it's true Motion is so far distant from the Sun, as the Parallax of Longitude amounts to, at the time of the true Conjunction; or it is the time between the seeming Conjunction and the Moment, that goes before or follows it, some Minutes. In the first Interval the point of Time, from which we begin to compute either backward or forward, is the Moment of the true Conjunction; in the other the Head or beginning of the Calculation proceeds from the seeming Conjunction

junction. For the Apparent Motion of the Moon therefore in the first Interval, let this be the first Rule: At both the Bounds of the Interval that is given, that is, at the time of the true Conjunction, and also at that point of time, that the Moon in its true Motion is distant from the Sun, as much as the Parallax of Longitude at the time of the true Conjunction amounts to, let there be in readiness the Parallax of Longitude, and let the Difference of these Parallaxes be taken. Then if the Parallax of Longitude at the time of the true Conjunction shall be greater than the Parallax that belongs to the other Bounds of the Interval, you must add the difference of Parallaxes to the Parallax that answers the very moment of the true Conjunction; and you shall have the apparent Motion of the Moon for the said Interval: But if the Parallax that belongs to the true Conjunction be less than the Parallax of the other Bound, then you must take away the difference of the Parallaxes from the Parallax that answers the true Conjunction, and again there will appear the Apparent Motion of the Moon for the said Interval. If you demand the reason of this way of working it; consider, that if the Parallaxes of both the Bounds of the given Interval were equal, then the Apparent Motion of the Moon would be equal to the true Motion: Wherefore the Apparent Motion differs as much from the true, as the difference of the Parallaxes comes to. Farthermore we must know, that all Parallaxes bring the Star nearer the Horizon, than it would be seen to be from the Centre of the Earth: Wherefore in the Eastern Quadrant of the *Zodiack*, the greater Parallaxes do the more help the proper Motion of the Moon towards the East, as the lesser Parallaxes do promote it the less. And seeing in the same Eastern Quadrant the true Conjunction does always follow the seeming one, and for the same reason also the other Bound of our Interval, which constantly tends from the true Conjunction to the seeming one; the following Bound of the true Conjunction, if it be help'd by a less Parallax than the foregoing is help'd by, must needs doe the less towards promoting the Moon towards the East, and so the Apparent Motion becomes less than the true; whereby it comes, that the difference of the Parallaxes is to be taken from the true Motion, that the Apparent Motion may be made out. The contrary happens, when the latter Bound (that is, of the true Conjunction) is help'd by a greater Parallax than the former is help'd, by which it comes, that the Moon is in its proper Motion thrust more and more Eastward. But in the Western Quadrant of the *Zodiack* the greater Parallaxes do move the Moon more towards the West, and so do retard its Motion Eastward. And since in the Western Quadrant the true Conjunction always goes before the seeming one, and so consequently before the other Bound of our Interval also, which always tends from the true to the seeming Conjunction; therefore if the foregoing Bound of the true Conjunction be retarded by the lesser Parallax, but the other following Bound by the greater, that Retardation must needs be always greater and greater; and so the Moon's Motion Eastward must be more and more hindred: Whereby the Apparent Motion does again become less than the true; and so it comes, that the difference of the Parallaxes is to be taken away from the true Motion But if the Parallax that answers the true Conjunction in the Western Quadrant be greater than the Parallax of the following Bound; then the Retardation of the Moon, which is greater at the Beginning of the Motion, grows less and less afterwards; and so it comes to pass, that the difference of the Parallaxes is to be added to the true Motion. Now the Parallax of the Moon above the Sun in Longitude, at the time of the true Conjunction, is the same with the true Motion of the Moon from the Sun in the said Interval. And hence it is, that for shortness sake the Rule puts that Parallax for this true Motion.

Now as for the Interval taken on this side, or beyond the seeming Conjunction, the latter Rule for finding the Moon's Apparent Motion is This: Let the Moons true Motion from the Sun at the Interval given be first of all in readiness; then at the beginning and end of that Interval let there be sought the Parallax of the Moon above the Sun in Longitude, and let the difference of these Parallaxes be taken. Afterwards consider, whether the whole given Time do pass, while the Sun is in the Eastern Quadrant of the Eclíptick, or all the while it is in the Western, or whether it be divided between both. If the whole time be spent in the Eastern Quadrant, and the Parallax at the beginning of the time be greater, than at the end, then take away the difference of the Parallaxes from the Moon's true Motion from the Sun; but if it be less, then add. But now if in all the given time the Sun be in

 the

the Western Quadrant, and the Parallax at the beginning of this time be greater than at the end, then add the differences of them to the Moon's true Motion from the Sun; but if it be less, then take it away. Lastly, if the Time given be divided etween both Quadrants, so as that the first part is spent in the Eastern, the latter in the Western Quadrant of the Ecliptick; then you must take the Summ of both Parallaxes from the Moon's true Motion from the Sun: So there comes the Moon's Apparent Motion from the Sun for the given Interval. You may easily gather the Reason of this latter Rule from what was just now said for the Explanation of the Former.

PROBLEM XI.

To compute the true Place of the Sun, and its Distance from the Earth by the Rudolphine *Tables.*

FOr the year 1582. *Nov.* 23. Current d. 16. ho. 0 min. from Noon-day, in Apparent time, let the true place of the Sun be demanded with respect to *Urenburgh*; that is, *Nov.* 24 Current d. of usual Time, 4 ho. in the Morning. Therefore by the first Precept of the first Problem, when the given time falls not in Leap-year after the end of *February*, and the Hours are in the Fore-noon, let two be taken from the given Number of days, and let Twelve be added to the Fore-noon Hours; so there is made *Nov.* the 22 complete d. 16 ho. and seeing the true place of the Sun is in 12 deg. ♐, there is taken out of the first part of the Table of Equation of time, the first part of the Equation of time, 6 min. (omitting the Seconds) with this Title, Subtract. Where the time first Equated becomes *Nov.* 22. d. 15 ho. 54 min. Again, by the same Precept of the first Problem, the Current year of our Lord being given, *viz.* 1582, let one be taken away, and there remains the complete year of our Lord, 1581, to which is always added the number 4713, and there is made the complete year of the *Julian* Period, 6294, and above *October* complete d. 15 ho. 54 min. which is the Astronomical time fitted for our going to the *Rudolphine* Tables. For the 7 min. 53 sec. which are mention'd in the Second precept of the first Problem, do not belong to the *Rudolphine*, but only to the Solar Tables of *Tycho*; though yet the latter part of the Equation of time is by all means to be fitted to this, as well as in *Tycho's* Solar Tables; which one thing I thought good to hint in the second Precept of Problem I. before mention'd, lest you should perchance mistake the sense of those words. But we shall then be able to find the latter part of the Equation of Time, when we have found the Sun's *Apogee*, and from that its middle Anomaly. But now omitting the *Epocha* of 6000 years, for the remaining time that has been laid open, we take out of Table XXVI. the Sun's middle Motion from the *Æquinox*, as follows:

	The mid. Mot. of ☉ from ♈.	
Years 200	0041981	
80	0016793	
14	0016628	
Octob. complete	8323241	
d. complete 22	0602340	
h. 15	0017112	
m. 54	0001027 *	* Note, that in the Table of Minutes one Cypher is still to be prefix'd.
	9019122	
The Epocha of 6000	7994972	Table XXV.
Mid.Mot. ☉ from ♈	1.7014094	

There

Fig. XLI.

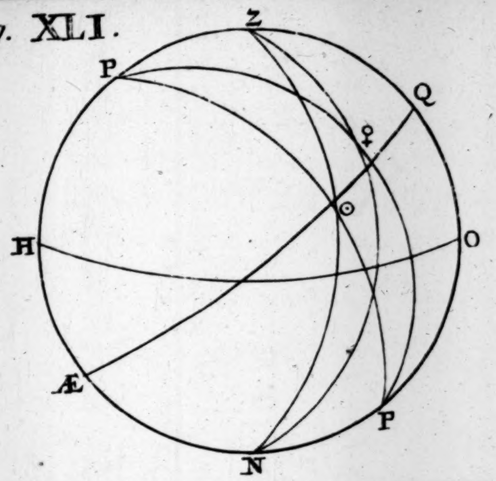


Fig. XLII.

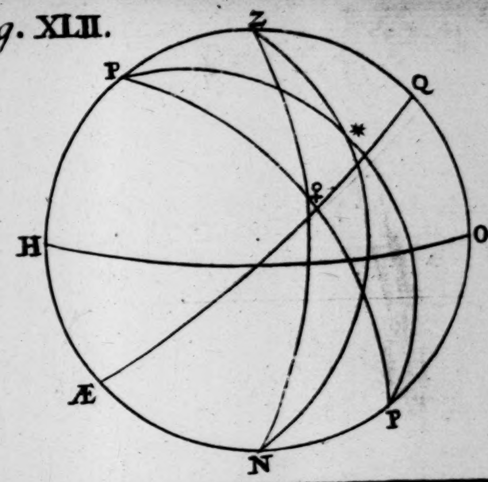


Fig. XLIII.

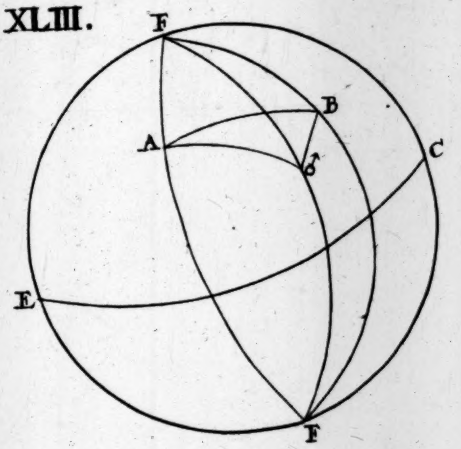


Fig. XLIV.

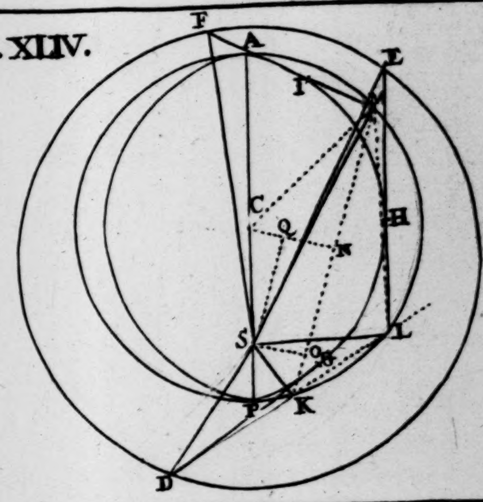


Fig. XLV.

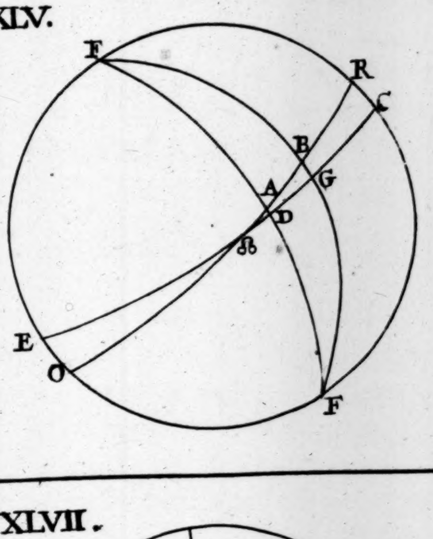


Fig. XLVI.

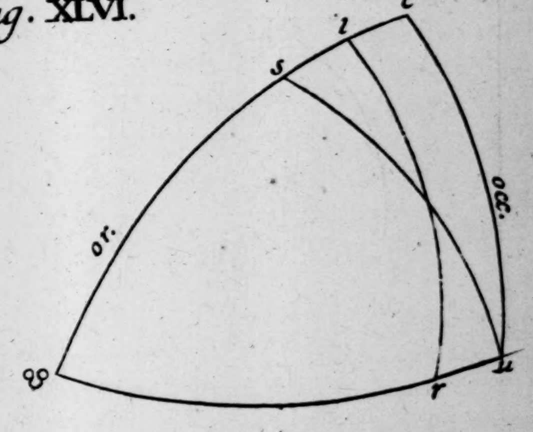


Fig. XLVII.

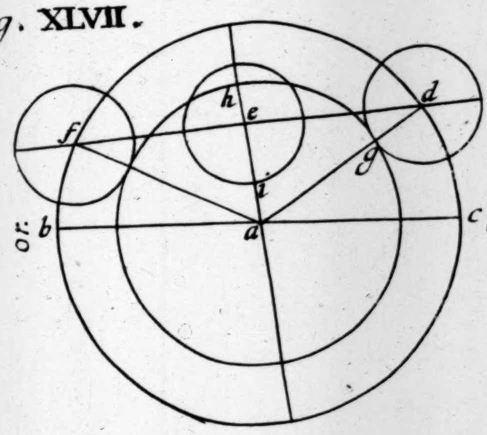


Fig. XLVIII.

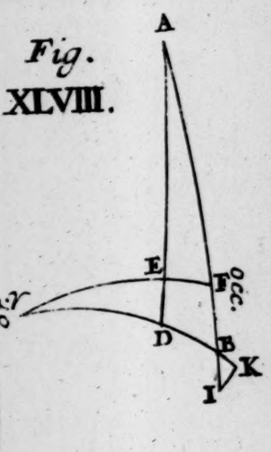
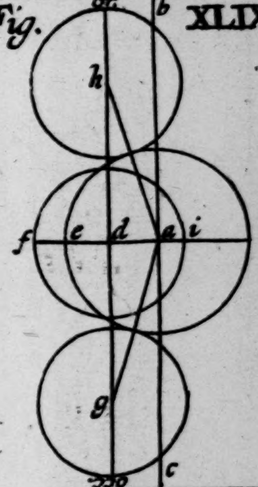


Fig. XLIX.



Against Page 828 to fold out.

There have past since the *Epocha* Tropical Years 294.9019
The Logarithm of which Number is 2.4696776 α
The Log. of the mid. Mot. of the Apog. of ⊙ in Trop. Y. 2.2334617 Table XXV.

The Log. of the mid. Apog of ⊙ in the time laid open is 0.7031393

	Sig.	Deg.	
Whose absolute Number is	0	5.0482	
The *Epocha* of the mid. Mot. of the Apog. of ⊙, 6000	3	0.3775	Table XXV.
The Place of the Apogée of the Sun	3	5.4257	β

	part. dec. circ.	Deg. with dec part.	
The middle Motion of the Sun from *Aries*	70	252.0	Table XXVII.
	14	0.504	
	09	0324	
	40	1440	
		252.5073840	

That is	8	12.5073	Subt.
The Place of the Sun's Apogée (β)	3	5.4257	
The middle Anomaly of the Sun	5	7.0816	

With which is taken out of the latter part of the Table of Equation of Time, the latter part of the Equation of Time 3 Min. (omitting the Seconds) with the Title, subtract. Wherefore the true Astronomical Time is *Nov.* 22d. 15 h. 51 Min. And now to those 3 Min. does answer out of Tab. XXVI. the Particle of the Sun's Motion 0000057, which is to be subtracted from the middle Motion of the Sun before found for the time laid open above the entire Revolutions, to wit, from 9019122; and there remains the same middle Motion of the Sun more exact 9019065. γ

And the same Particle of the Sun's Motion, *viz.* 0000057 being multiplied by 36, the two last Figures being cast away, it affords 0.0021 decimal parts of a degree, which are also to be drawn from the middle Motion of the Sun from *Aries*, above turn'd, to wit, from 8 Sig. 12 Deg. 5073, and the same will remain more exact, *viz* of 8 Sig. 12 Deg. 5052. δ

With the middle Anomaly of the Sun, 5 Sig. 7 Deg. 0816 is taken out of Table XXVIII. the *Prosthaph.* of the Sun 0.8195 S. which if it be taken from the middle Motion 8 Sig. 12 Deg. 5052, there remains the true Place of the Sun 8 Sig. 11 Deg. 6857. Now to the same middle Anomaly 5 Sig. 7 Deg. 0816 does answer out of the same Table XXVIII. the Logarithm of the Distance of the Sun from the Earth, *viz.* 399277. ε

PROBLEM XII.

To find the Heliocentrick Place of the five Planets in the Eclipticks, and also the curtail'd Distance of the same from the Sun.

THE middle Motion of the Sun for the time laid open, above the entire Revolutions, and which was mark'd in the foregoing Problem by the Letter γ, was 9019065.

To

To which does answer the Log.	1.9551615	
The Log. of the mid. Mot. of ♂ in a Tropical Year	1.7256683	Table XXXV.
The Log. of the mid. Mot. of ♂ for the time laid open above the entire Revolutions	1.6808298	

To which answers the absolute Number		4795455	Table XXXV.
The Tropical Years	4	1268075	
	90	8531690	
	200	340370	
The *Epocha*	6000	426188	
The middle Motion of *Mars* from *Aries*		2.2260860	

The Log. of the Tropical Years from the *Epocha* (α)	2.4696776	
The Log. of the Mot. of the Aphel. of ♂ in a Trop. Y.	2.2694130	Table XXXV.
The Log. of the Mot. of the Aphel. of ♂ in time expan.	0.7390906	

	Sig.	Deg.	
Whose absolute Number is	0	5.4839	
The *Epocha* of the Aphel. of *Mars* 6000	4	23.1778	Table XXXV.
The Place of the Aphelion of *Mars*	4	28.6617	ζ.

	Decimal Parts of a Circle.	*Deg. with Decimal Parts.*	
The middle Motion of *Mars* from *Aries*	22	079.2	Table XXVII.
	60	2.160	
	86	3096	
		81.39096	

	Sig.	Deg.	
That is	2	21.39096	Subt.
The Place of the Aphelion of *Mars* (ζ)	4	28.6617	
The middle Anomaly of *Mars*	9	22.7292	

With which is taken out of Table XXXVI. the *Prosthaphæresis* of *Mars* 9.3308 A. which being therefore added to the middle Motion of *Mars* from *Aries*, to wit, 2 Sig. 21 Deg. 3909, it makes the Heliocentrick Place of *Mars* in the Orbit 3 Sig. 7217. η

Again: The Log. of a Trop. Y. from the *Epocha* (α) is	2.4696776	
The Log. of the Mot. ☊ ♂ from ♈	2.0429783	Table XXXV.
The Log. of the Mot. ☊ ♂ in time laid open	0.5126559	

	Sig.	Deg.
Whose absolute Number is	0	3.2558
The *Epocha* ☊ ♂ 6000	1	13.2867
The Place ☊ ♂	1	16.5425

	Sig.	Deg.
From the Heliocentrick Place of ♂ in the Orbit (η)	3	0.7217
Take the Place of ☊ ♂	1	16.5425
There remains the Argument of the Latitude of *Mars*	1	14.1792

With which, out of Table XXXVII. is taken the Inclination of *Mars* 1.2838, and the Reduction 0.0147 S.

There-

	Sig.	Deg.	
Therefore from the Helioc. Place ♂ in the Orbit ——	3	0.7217	
Take the Reduction —— —— ——	0	0.0147	S.
And there remains the Helioc. Place of ♂ in the Eclip.	3	0.7070	θ

Again With the middle Anomaly of *Mars* Sig. 9 Deg. 22. 7292. out of Table XXXVI. is taken the Distance of *Mars* from the Sun 420100; and of the Inclination of *Mars* 1.2838 the Sign of Complement is 999989, whose Arithmetical Complement is 11, which is the Curtation of the Distance of *Mars*, to be taken from the former Distance of 420100, that there may remain the curtail'd Distance of *Mars* from the Sun 420089. ι

PROBLEM XIII.

To determine the Geocentrick place of the Planets in the Zodiack according to Longitude and Latitude.

IN the Triangle that lies between the Sun, the Earth, and the Planet, are given the two sides, that are extended from the Sun to the Earth and the Planet, with the External Angle to the Sun; to wit, by taking away the true place of the Sun from the Heliocentrick place of the Planet in the Ecliptick; or this from that, that the Remainder may be less than the Semicircle. And here is sought the Angle to the Earth, which, in the upper Planets, is the greatest of the unknown Angles, because opposite to an upper Planet's distance from the Sun, that is greater than that of the Earth; but in the lower Planets it is less, because opposite to a less distance of a lower Planet. In our Example therefore,

	Sig.	Deg.	
The true place of the Sun found by Prob. XI. is	8	11.6857	Subtract
The Heliocentrick place of ♂, found by Prob. XII. (θ)	3	0.7070	
The External Angle to the Sun,	5	10.9787	
The half of which, is ——	2	20.4893	
The Curtail'd distance of ♂ from ☉ by Prob. XII. (ι)		420089	Subtract
The distance of the Earth from the Sun, Prob. XI. (ε)		399277	

1020812	58.2314
	45
937130	13.2314
1077589	80.4893
1014719	54.5283

The Angle to the Earth, 135.0176

	Sig.	Deg.
That is	4	15.0176
The true place of the Sun,	8	11.6857
The Geocentrick place of ♂.	3	26.6681

And here you must take notice of this Rule: When the Heliocentrick place of the Planet in the Ecliptick, has been taken away from the true place of the Sun, as in this example; then the Angle from the Earth is likewise taken from the Sun's true place: But if the true place of the Sun be taken from the Heliocentrick place of the Planet; then the Angle to the Earth is added to the Sun's true place, that the Geocentrick place of the Planet may appear.

For

For the finding the Latitude of a Planet.

The Rule was given Section the II. of this Book, Chap. XXIII.

As the Sign of the Angle to ☉	(160.9787)	951311
is to the Sign of the Angle to the Earth,	(135.0176)	984935
So is the Arch of Inclination	(1.2838)	010850
to the Arch of Latitude.	(2.7844)	044474

The Latitude of *Mars* is found to be 2.7844; which, because the Argument of Latitude by the foregoing Problem, was 1 Sig. 14 Deg. 1792, is therefore Ascending Northward, while the Planets tend from ☊ to the Northern limit; thence to ☋ it is North descending; from ☋ to the Southern Limit, it is South, descending; lastly, from the Southern Limit to ☊ it is South ascending.

PROBLEM XIV.

To find the Longitude and Latitude of the fix'd Stars at any time that is given.

IN the beginning of the Year 1676. let the Longitude of the first Star in *Aries* be sought: Taking one from the year given, there remains the compleat year of our Lord 1675, and adding 4713, there is made the compleat year of the *Julian* Period, 6388.

The Logarithm of 388 is	2.58883	
The Logarithm of the middle Motion of the fix'd Stars in a Tropical year.	2.15126	Tab. XXV.
	0.74009	

	Sig.	Deg.	
Whose absolute number ——— ———	0	5.4966	
The Epocha 6000. ——— ———	0	23.1825	Tab. XXV.
The Longitude of the first Star of ♈, ———	0	28.6791	
The Longitude of *Sirius* from the first Star of ♈,	2	10.975	Tab. XLIV.
The Longitude of *Sirius* from the *Æquinox*,	3	9.6541	
The Latitude of *Sirius*, ——— ———	0	39.500	Tab. XLIV.

Now the Latitudes of the fix'd Stars, are by most Learned Astronomers thought to be unchangeable, and therefore they continue always the same, as they are taken out of the XLIV Table; but if the Longitude of any Star be demanded at any other time after the beginning of the year, you must add for every Month, 0.0012, and for every week 0.0003 parts (*i e*, 10000 parts) of one degree.

And now having shown the use of *Tycho's*, as well as of the *Rudolphine* Tables, both by Precepts and Examples, I shall hear to this IV. Section, and so to my Astronomical Institutions put

AN END.

TYCHO'S SOLAR and LUNAR TABLES.

TABLE I.

Tycho's *Solar* Epochæ, *according to the Meridian of* Urenburgh, *at Mid-day in the Calends of* January.

Years of Christ.	*Motion of the Sun.* Si.	De.	Mi.	Se.	*Anomaly of the Sun.* Si.	De.	Mi.	Se.	*Place of the Apogee.* Si.	De.	Mi.	Se.
1401	9	19	22	47	6	16	13	02	3	03	09	45
1501	9	20	09	00	6	15	44	15	3	04	24	45
1601	9	20	55	12	6	15	15	27	3	05	39	45
1701	9	21	41	24	6	14	46	39	3	06	54	45
1801	9	22	27	36	6	14	17	51	3	08	09	45

TABLE II.

A Table of twenty expanded Years.

Years	*Motion of the Sun.* Si.	De.	Mi.	Se.	Th.	*Anomaly of the Sun.* Si.	De.	Mi.	Se.	*Motion of the Apogee.* De.	Mi.	Se.
1	11	29	45	40	38	11	29	44	55	00	00	45
2	11	29	31	21	16	11	29	29	51	00	01	30
3	11	29	17	01	55	11	29	14	47	00	02	15
4	00	00	01	50	53	11	29	58	51	00	03	00
5	11	29	47	31	31	11	29	43	46	00	03	45
6	11	29	33	12	09	11	29	28	42	00	04	30
7	11	29	18	52	47	11	29	13	38	00	05	15
8	00	00	03	41	46	11	29	57	42	00	06	00
9	11	29	49	22	24	11	29	42	37	00	06	45
10	11	29	35	03	02	11	29	27	33	00	07	30
11	11	29	20	43	40	11	29	12	29	00	08	15
12	00	00	05	32	38	11	29	56	33	00	09	00
13	11	29	51	13	17	11	29	41	28	00	09	45
14	11	29	36	53	55	11	29	26	24	00	10	30
15	11	29	22	34	33	11	29	11	20	00	11	15
16	00	00	07	23	31	11	29	55	23	00	12	00
17	11	29	53	04	09	11	29	40	19	00	12	45
18	11	29	38	44	48	11	29	25	15	00	13	30
19	11	29	24	25	26	11	29	10	10	00	14	15
20	00	00	09	14	24	11	29	54	14	00	15	00
40	00	00	18	28	48	11	29	48	29	00	30	00
60	00	00	27	43	12	11	29	42	43	00	45	00
80	00	00	36	57	37	11	29	36	58	01	00	00
100	00	00	46	12	01	11	29	31	12	01	15	00

TABLE III.

A Table of Months in a common Year.

Months.	*Motion of the Sun.* Si.	De.	Mi.	Se.	Th.	*Anomaly of the Sun.* Si.	De.	Mi.	Se.	*Ap. Mot.* Se.	Th.
January	00	00	00	00	00	00	00	00	00	00	00
February	01	00	33	18	15	01	00	33	14	03	49
March	01	28	09	11	30	01	28	09	04	07	16
April	02	28	42	29	45	02	28	42	19	11	05
May	03	28	16	39	40	03	28	16	25	14	47
June	04	28	49	57	54	04	28	49	39	18	36
July	05	28	24	07	49	05	28	23	45	22	18
August	06	28	57	26	04	06	28	57	00	26	08
September	07	29	30	44	19	07	29	30	14	29	57
October	08	29	04	54	14	08	29	04	20	33	40
November	09	29	38	12	28	09	29	37	35	37	29
December	10	29	12	22	23	10	29	11	41	41	11
Yearly Mot.	11	29	45	40	38	11	29	44	55	45	00

TABLE IV.

A Table of Days.

Days.	*Motion of the Sun.* De.	Mi.	Se.	Th.	*Days.*	*Motion of the Sun.* De.	Mi.	Se.	Th.
1	00	59	08	20	17	16	45	21	57
2	01	58	16	40	18	17	44	29	17
3	02	57	24	59	19	18	43	38	37
4	03	56	33	19	20	19	42	46	56
5	04	55	41	39	21	20	41	54	37
6	05	54	41	59	22	21	41	03	16
7	06	53	58	19	23	22	40	11	36
8	07	53	06	39	24	23	30	19	56
9	08	52	14	58	25	24	38	28	16
10	09	51	23	18	26	25	37	36	35
11	10	50	31	38	27	26	36	44	55
12	11	49	39	58	28	27	35	53	15
13	12	48	48	18	29	28	35	01	35
14	13	47	56	37	30	29	34	09	55
15	14	47	04	57	31	30	33	18	15
16	15	46	13	17					

TABLE V.

An Horary Table of the Sun.

Hours and Scru.	*Motion of the Sun.* Mi.	Sec.	Th.	*Hour and Scru.*	*Motion of the Sun.* Mi.	Sec.	Th.	*Ho. and Scr.*	*Motion of the Sun.* Mi.	Sec.	*Scrup. and Hours.*	*Motion of the Sun.* Min.	Sec.
1	02	27	51	17	41	53	24	32	1	19	48	1	58
2	04	55	42	18	44	21	15	33	1	21	49	2	01
3	07	23	32	19	46	49	06	34	1	24	50	2	03
4	09	51	23	20	49	16	56	35	1	26	51	2	06
5	12	19	14	21	51	44	47	36	1	29	52	2	08
6	14	47	05	22	54	12	38	37	1	31	53	2	10
7	17	14	56	23	56	40	29	38	1	34	54	2	13
8	19	42	46	24	59	08	20	39	1	36	55	2	16
9	22	10	37	*Scru.*	mi.	sec.	th	40	1	38	56	2	18
10	24	38	28	25	01	01	36	41	1	41	57	2	20
11	27	06	19	26	01	04	04	42	1	43	58	2	23
12	29	34	10	27	01	06	32	43	1	46	59	2	25
13	32	02	01	28	01	09	00	44	1	48	60	2	28
14	34	29	51	29	01	11	27	45	1	51			
15	36	57	42	30	01	13	55	46	1	53		Sec.	Th.
16	39	25	33	31	01	16	23	47	1	56			
	Sec.	Th.	Fo.		Sec.	Th.	Fo.		Sec.	Th.			

TABLE VI.

Lunar Epochæ, *instituted by* Tycho *himself, serving for the four next following Ages.*

Years of Christ.	*Long. of the Moon from the Sun.* Sig.	Deg.	Min.	Sec.	*Anom of the Moon.* Sig.	Deg.	Min.	Se.	*Mot. of the Moon's Lat.* Sig.	Deg.	Min.	Se.
1401	06	15	09	26	03	23	28	46	09	24	47	13
1501	04	22	13	19	10	11	59	11	00	16	47	17
1601	02	29	17	13	05	00	29	35	03	08	47	04
1701	01	06	21	06	11	19	00	00	06	00	46	50
1801	11	13	25	00	06	07	30	25	08	22	46	36

TABLE VII.

A Table of twenty expanded Years.

Years	*Long. of the Moon from the Sun.* Sig.	Deg.	Min.	Se.	Th.	*Anom. of the Moon.* Sig.	Deg	Min.	Se	*Mot. of the Moon's Lat.* Sig.	Deg.	Min.	Sec.
1	04	09	37	22	40	02	28	43	08	04	28	42	45
2	08	19	14	45	19	05	27	26	15	09	27	25	31
3	00	28	52	07	59	08	26	09	23	02	26	08	16
4	05	20	40	57	20	00	07	56	25	08	08	04	47
5	10	00	18	20	00	03	06	39	33	01	06	47	33

The Residue of Table VII.

A Table of twenty expanded Years.

Years	*Long. of the Moon from the Sun.* Sig.	Deg.	Min.	Sec.	Th.	*Anom. of the Moon.* Sig.	Deg	Min.	Se.	*Mot. of the Moon's Lat.* Sig.	Deg.	Min.	Se.
6	02	09	55	42	40	06	05	22	40	06	05	30	18
7	06	19	33	05	19	09	04	05	48	11	04	13	04
8	11	11	21	54	41	00	15	52	50	04	16	09	35
9	03	20	59	17	20	03	14	35	58	09	14	52	20
10	08	00	36	40	00	06	13	19	05	02	13	35	06
11	00	10	14	02	40	09	12	02	13	07	12	17	51
12	05	02	02	52	01	00	23	49	15	00	24	14	22
13	09	11	40	14	41	03	22	32	23	05	22	57	08
14	01	21	17	37	20	06	21	15	30	10	21	39	53
15	06	00	55	00	00	09	19	58	38	03	20	22	39
16	10	22	43	49	21	01	01	45	40	09	02	19	10
17	03	02	21	12	01	04	00	28	48	02	01	01	55
18	07	11	58	34	41	06	29	11	55	06	29	44	41
19	11	21	35	57	21	09	27	55	03	11	28	27	26
20	04	13	24	46	42	01	09	42	05	05	10	23	57
40	08	26	49	33	24	02	19	24	10	10	20	47	54
60	01	10	14	20	06	03	29	06	15	04	01	11	52
80	05	23	39	06	48	05	08	48	20	09	11	35	49
100	10	07	03	53	30	06	18	30	25	02	21	59	46

TABLE VIII.

A Table of Months in a Common Year.

Months.	*Long. from the Sun.* Si.	De.	Mi.	Se.	Th.	*Anom. of the Moon.* Si.	De.	Mi.	Se.	*Mot. of the Moon's Lat.* Si.	De.	Mi.	Sec.
January	00	00	00	00	00	00	00	00	00	00	00	00	00
February	00	17	54	47	27	01	15	00	52	01	20	06	35
March	11	29	15	14	50	01	20	50	02	02	00	31	54
April	00	17	10	02	18	03	05	50	55	03	20	38	29
May	00	22	53	23	04	04	07	47	53	04	27	31	19
June	01	10	48	10	31	05	22	48	45	06	17	37	54
July	01	16	31	31	17	06	24	45	43	07	24	30	44
August	02	04	26	18	45	08	09	46	35	09	14	37	20
September	02	22	21	06	13	09	24	47	27	11	04	43	55
October	02	28	04	26	58	10	26	44	25	00	11	36	45
Novemb.	03	15	59	14	26	00	11	45	17	02	01	43	20
Decemb.	03	21	42	35	12	01	13	42	16	03	08	36	10
Years Mot.	04	09	37	22	40	02	28	43	08	04	28	42	45

TABLE IX.

A Table of Days.

Days.	*Long. of the Moon from the Sun.* Sig.	Deg.	Min.	Sec.	Th.	*Anom. of the Moon.* Sig.	Deg.	Min.	Se.	*Mot. of the Moon's Lat.* Sig.	Deg.	Min.	Se.
1	00	12	11	26	41	00	13	03	54	00	13	13	46
2	00	24	22	53	03	00	26	07	48	00	26	27	31
3	01	06	34	20	05	01	09	11	42	01	09	41	17
4	01	18	45	46	46	01	22	15	36	01	22	55	03
5	02	00	57	13	28	02	05	19	30	02	06	08	48
6	02	13	08	40	09	02	18	23	24	02	10	22	34
7	02	25	20	06	51	03	01	27	18	03	02	36	20
8	03	07	31	33	32	03	14	31	11	03	15	50	05
9	03	19	43	00	14	03	27	35	05	03	29	03	51
10	04	01	54	26	55	04	10	38	59	04	12	17	37
11	04	14	05	53	37	04	23	42	53	04	25	31	22
12	04	26	17	20	18	05	06	46	47	05	08	45	08
13	05	08	28	47	00	05	19	50	41	05	21	58	54
14	05	20	40	13	41	06	02	54	35	06	05	12	39
15	06	02	51	40	23	06	15	58	29	06	18	26	25
16	06	15	03	07	05	06	29	02	23	07	01	40	11
17	06	27	14	33	46	07	12	06	17	07	14	53	56
18	07	09	26	00	28	07	25	10	11	07	28	07	42
19	07	21	37	27	09	08	08	14	05	08	11	21	27
20	08	03	48	53	51	08	21	17	59	08	24	35	13
21	08	16	00	20	32	09	04	21	53	09	07	48	59
22	08	28	11	47	14	09	17	25	47	09	21	02	44
23	09	10	23	13	55	10	00	29	41	10	04	16	30
24	09	22	34	40	37	10	13	33	34	10	17	30	16
25	10	04	46	07	18	10	26	37	28	11	00	44	01
26	10	16	57	34	00	11	09	41	22	11	13	57	47
27	10	29	09	00	41	11	22	45	16	11	27	11	33
28	11	11	20	27	23	00	05	49	10	00	10	25	18
29	11	23	31	53	04	00	18	53	04	00	23	39	04
30	00	05	43	20	46	01	01	56	58	01	06	52	50
31	00	17	54	47	27	01	15	00	52	01	20	06	35

TABLE X.

An Horary Table of the Moon.

Ho. and Scrup.	*Long. of the Moon from the Sun.* Deg.	Min.	Sec.	Th.	*Anom. of the Moon.* Deg.	Min.	Sec.	*Mot. of the Moon's Lat.* Deg.	Min.	Sec.
1	00	30	28	37	00	32	40	00	33	05
2	01	00	57	13	01	05	19	01	06	10
3	01	31	25	50	01	37	59	01	39	14
4	02	01	54	27	02	10	39	02	12	19
5	02	32	23	04	02	43	19	02	45	23

The Residue of Table X.

An Horary Table of the Moon.

Ho. and Scrup.	*Long. of the Moon from the Sun.* Deg.	Min.	Sec.	Th.	*Anom. of the Moon.* De.	Mi.	Se.	*Mot. of the Moon's Lat.* De.	Mi.	Se.
6	03	02	51	40	03	15	58	03	18	27
7	03	33	20	17	03	48	38	03	51	32
8	04	03	48	54	04	21	18	04	24	36
9	04	34	17	30	04	53	58	04	57	41
10	05	04	46	07	05	26	37	05	30	45
11	05	35	14	44	05	59	17	06	03	49
12	06	05	43	21	06	31	57	06	36	54
13	06	36	11	57	07	04	37	07	09	58
14	07	06	40	34	07	37	16	07	43	03
15	07	37	09	11	08	09	56	08	16	07
16	08	07	37	48	08	42	36	08	49	11
17	08	38	06	24	09	15	16	09	22	16
18	09	08	35	01	09	47	55	09	55	20
19	09	39	03	38	10	20	35	10	28	25
20	10	09	32	15	10	53	15	11	01	29
21	10	40	00	51	11	25	55	11	34	33
22	11	10	29	28	11	58	34	12	07	38
23	11	40	58	05	12	31	14	12	40	42
24	12	11	26	41	12	03	54	13	13	48

Scru.	Min.	Sec.	Th.	Mi.	Se.	Mi.	Se.
25	12	41	55	13	37	13	47
26	13	12	24	14	09	14	20
27	13	43	52	14	42	14	53
28	14	13	21	15	15	15	26
29	14	43	50	15	47	15	59
30	15	14	18	16	20	16	32
31	15	44	47	16	53	17	05
32	16	15	16	17	25	17	38
33	16	45	44	17	58	18	11
34	17	16	13	18	31	18	44
35	17	46	41	19	03	19	18
36	18	17	10	19	36	19	51
37	18	47	39	20	08	20	24
38	19	18	07	20	41	20	57
39	19	48	36	21	14	21	30
40	20	19	04	21	46	22	03
41	20	49	33	22	19	22	36
42	21	20	02	22	51	23	09
43	21	50	30	23	24	24	42
44	22	20	59	23	57	24	15
45	22	51	27	24	30	24	48

The Residue of Table X.

An Horary Table of the Moon.

Ho. and Scrup.	Long. of the Moon from the Sun. Min.	Sec.	Th.	Anom. of the Moon. Mi.	Se.	Mot. of the Moon's Lat Mi.	Se.
46	23	21	56	25	03	25	21
47	23	52	25	25	35	25	54
48	24	22	53	26	08	26	27
49	24	53	22	26	41	27	00
50	25	23	50	27	13	27	34
51	25	54	19	27	46	28	07
52	26	24	48	28	18	28	40
53	26	55	16	28	51	29	13
54	27	25	45	29	24	29	46
55	27	56	14	29	56	30	19
56	28	26	42	30	29	30	52
57	28	57	11	31	01	31	25
58	29	27	39	31	34	31	58
59	29	58	08	32	07	32	31
60	30	28	37	32	40	33	05

TABLE XI.

Prosthaphæreses *or* Equations.

Sign 0								
Deg. desc.	*The Sun.* Subtract. De.	Mi.	Se.	*The Moon.* Subtract. De.	Mi.	Se.	*The Elongation of the Moon from the Centre of the Eccentrick.*	*Deg. asc.*
0	0	00	00	0	00	00	102900	30
1	0	02	05	0	05	04	102899	29
2	0	04	10	0	10	08	102898	28
3	0	06	14	0	15	12	102896	27
4	0	08	18	0	20	16	102894	26
5	0	10	22	0	25	20	102891	25
6	0	12	26	0	30	23	102888	24
7	0	14	30	0	35	26	102884	23
8	0	16	33	0	40	28	102879	22
9	0	18	36	0	45	29	102873	21
10	0	20	39	0	50	30	102867	20
11	0	22	41	0	55	30	102860	19
12	0	24	43	1	00	28	102853	18
13	0	26	45	1	05	25	102845	17
14	0	28	47	1	10	21	102836	16
15	0	30	48	1	15	16	102826	15
16	0	32	49	1	20	10	102816	14
17	0	34	49	1	25	03	102805	13
18	0	36	48	1	29	55	102793	12
19	0	38	47	1	34	44	102781	11
20	0	40	45	1	39	32	102768	10
21	0	42	43	1	44	18	102755	9
22	0	44	40	1	49	03	102741	8
23	0	46	36	1	53	47	102726	7
24	0	48	31	1	58	29	102711	6
25	0	50	25	2	03	08	102695	5
26	0	52	18	2	07	44	102678	4
27	0	54	11	2	12	18	102660	3
28	0	56	03	2	16	50	102642	2
29	0	57	54	2	21	20	102623	1
30	0	59	44	2	25	47	102604	0
	Add			Add				
Sign 11.								

The Residue of Table XI.

Prosthaphæreses *or* Equations.

Sign 1.								
Deg. desc.	*The Sun.* *Subtract.* De.	Mi.	Sc.	*The Moon.* *Subtract.* De.	Mi.	Sc.	*The Elongation of the Moon from the Centre of the Eccentrick.*	*Deg. asc.*
0	0	59	44	2	25	47	102604	30
1	1	01	33	2	30	12	102584	29
2	1	03	21	2	34	34	102563	28
3	1	05	08	2	38	54	102542	27
4	1	06	54	2	43	11	102520	26
5	1	08	38	2	47	25	102497	25
6	1	10	21	2	51	37	102474	24
7	1	12	03	2	55	46	102450	23
8	1	13	44	2	59	52	102426	22
9	1	15	24	3	03	54	102401	21
10	1	17	03	3	07	53	102375	20
11	1	18	40	3	11	49	102348	19
12	1	20	16	3	15	42	102321	18
13	1	21	51	3	19	31	102293	17
14	1	23	24	3	23	17	102265	16
15	1	24	56	3	26	59	102236	15
16	1	26	27	3	30	38	102206	14
17	1	27	56	3	34	13	102176	13
18	1	29	23	3	37	44	102145	12
19	1	30	49	3	41	12	102114	11
20	1	32	13	3	44	36	102082	10
21	1	33	36	3	47	56	102049	9
22	1	34	58	3	51	12	102016	8
23	1	36	18	3	54	24	101982	7
24	1	37	36	3	57	32	101948	6
25	1	38	52	4	00	36	101913	5
26	1	40	06	4	03	35	101877	4
27	1	41	18	4	06	30	101841	3
28	1	42	29	4	09	21	101804	2
29	1	43	38	4	12	08	101767	1
30	1	44	46	4	14	51	101729	0
	Add			Add				
Sign 10.								

The Residue of Table XI.

Prosthaphæreses *or* Equations.

Sign 2.								
Deg. desc.	*The Sun.* *Subtract.* De.	Mi.	Se.	*The Moon.* *Subtract.* De.	Mi.	Se.	*The Elongation of the Moon from the Centre of the Eccentrick.*	*Deg. asc.*
0	1	44	47	4	14	51	101729	30
1	1	45	53	4	17	29	101691	29
2	1	46	57	4	20	02	101652	28
3	1	47	59	4	22	31	101613	27
4	1	48	59	4	24	55	101573	26
5	1	49	57	4	27	14	101532	25
6	1	50	53	4	29	29	101491	24
7	1	51	47	4	31	39	101449	23
8	1	52	39	4	33	44	101407	22
9	1	53	30	4	35	44	101365	21
10	1	54	19	4	37	39	101322	20
11	1	55	07	4	39	30	101279	19
12	1	55	52	4	41	17	101235	18
13	1	56	34	4	42	59	101191	17
14	1	57	14	4	44	35	101146	16
15	1	57	52	4	46	05	101101	15
16	1	58	28	4	47	30	101055	14
17	1	59	02	4	48	50	101009	13
18	1	59	34	4	50	06	100963	12
19	2	00	04	4	51	16	100916	11
20	2	00	32	4	52	21	100869	10
21	2	00	58	4	53	21	100821	9
22	2	01	22	4	54	16	100773	8
23	2	01	43	4	55	05	100725	7
24	2	02	02	4	55	49	100676	6
25	2	02	19	4	56	28	100627	5
26	2	02	33	4	57	01	100578	4
27	2	02	45	4	57	29	100528	3
28	2	02	55	4	57	51	100478	2
29	2	03	03	4	58	08	100428	1
30	2	03	09	4	58	20	100378	0
	Add			Add				
Sign 9.								

The Residue of Table XI.

Prosthaphæreses *or* Equations.

Sign 3								
Deg. desc.	*The Sun.* Subtract. De.	Mi.	Se.	*The Moon.* Subtract. De.	Mi.	Se.	*The Elongation of the Moon from the Centre of the Eccentrick.*	*Deg. asc.*
0	2	03	09	4	58	20	100378	30
1	2	03	13	4	58	26	100327	29
2	2	03	15	4	58	27	100276	28
3	2	03	13	4	58	22	100225	27
4	2	03	09	4	58	14	100174	26
5	2	03	03	4	57	59	100123	25
6	2	02	55	4	57	37	100072	24
7	2	02	45	4	57	10	100021	23
8	2	02	33	4	56	38	99969	22
9	2	02	19	4	56	01	99917	21
10	2	02	02	4	55	18	99865	20
11	2	01	43	4	54	30	99813	19
12	2	01	22	4	53	36	99761	18
13	2	00	58	4	52	37	99709	17
14	2	00	32	4	51	33	99657	16
15	2	00	04	4	50	23	99605	15
16	1	59	34	4	49	07	99553	14
17	1	59	02	4	47	46	99501	13
18	1	58	27	4	46	21	99449	12
19	1	57	50	4	44	50	99397	11
20	1	57	11	4	43	13	99343	10
21	1	56	30	4	41	31	99293	9
22	1	55	46	4	39	43	99242	8
23	1	55	00	4	37	51	99191	7
24	1	54	12	4	35	54	99140	6
25	1	53	21	4	33	51	99089	5
26	1	52	28	4	31	42	99038	4
27	1	51	33	4	29	29	98987	3
28	1	50	36	4	27	11	98937	2
29	1	49	37	4	24	48	98887	1
30	1	48	36	4	22	20	98838	0
		Add			Add			
Sign 8.								

The Residue of Table XI.

Prosthaphæreses *or* Equations.

Sign 4.									
Deg. desc.	*The Sun.*			*The Moon.*			*The Elongation of the Moon from the Centre of the Eccentrick.*	*Deg. asc.*
	Subtract.			*Subtract.*				
	De.	Mi.	Se.	De.	Mi.	Se.		
0	1	48	36	4	22	20	98838	30
1	1	47	33	4	19	46	98789	29
2	1	46	28	4	17	07	98740	28
3	1	45	21	4	14	24	98691	27
4	1	44	12	4	11	36	98643	26
5	1	43	01	4	08	43	98595	25
6	1	41	47	4	05	45	98547	24
7	1	40	31	4	02	42	98500	23
8	1	39	14	3	59	35	98453	22
9	1	37	55	3	56	23	98407	21
10	1	36	35	3	53	06	98361	20
11	1	35	13	3	49	45	98316	19
12	1	33	49	3	46	20	98272	18
13	1	32	23	3	42	50	98228	17
14	1	30	54	3	39	16	98185	16
15	1	29	23	3	35	38	98142	15
16	1	27	50	3	31	55	98100	14
17	1	26	16	3	28	08	98059	13
18	1	24	40	3	24	18	98018	12
19	1	23	03	3	20	24	97978	11
20	1	21	25	3	16	25	97938	10
21	1	19	46	3	12	22	97899	9
22	1	18	05	3	08	15	97861	8
23	1	16	22	3	04	05	97824	7
24	1	14	36	2	59	52	97787	6
25	1	12	48	2	55	35	97751	5
26	1	10	59	2	51	14	97716	4
27	1	09	09	2	46	49	97682	3
28	1	07	58	2	42	21	97649	2
29	1	05	26	2	37	51	97616	1
30	1	03	33	2	33	18	97584	0
	Add			Add				
Sign 7.								

The Residue of Table XI.

Prosthaphæreses *or* Equations.

Sign 5								
Deg. desc.	*The Sun.* Subtract. De.	Mi.	Sc.	*The Moon.* Subtract. De.	Mi.	Sc.	*The Elongation of the Moon from the Centre of the Eccentrick.*	*Deg. asc.*
0	1	03	33	2	33	18	97584	30
1	1	01	40	2	28	41	97553	29
2	0	59	45	2	24	01	97523	28
3	0	57	48	2	19	14	97494	27
4	0	55	49	2	14	33	97466	26
5	0	53	48	2	09	45	97439	25
6	0	51	47	2	04	55	97413	24
7	0	49	45	2	00	02	97384	23
8	0	47	43	1	55	07	97364	22
9	0	45	40	1	50	09	97341	21
10	0	43	36	1	45	08	97320	20
11	0	41	31	1	40	05	97299	19
12	0	39	25	1	35	01	97279	18
13	0	37	18	1	29	55	97260	17
14	0	35	10	1	24	47	97242	16
15	0	33	01	1	19	38	97225	15
16	0	30	52	1	14	27	97209	14
17	0	28	42	1	09	14	97194	13
18	0	26	32	1	03	59	97180	12
19	0	24	21	0	58	43	97167	11
20	0	22	10	0	53	27	97155	10
21	0	19	59	0	48	10	97144	9
22	0	17	47	0	42	52	97134	8
23	0	15	35	0	37	33	97126	7
24	0	13	22	0	32	13	97120	6
25	0	11	09	0	26	52	97115	5
26	0	08	56	0	21	30	97111	4
27	0	06	42	0	16	08	97108	3
28	0	04	28	0	10	46	97105	2
29	0	02	14	0	05	23	97102	1
30	0	00	00	0	00	00	97100	0
	Add			Add				
Sign 6.								

TABLE XII.

The Second and Third Prosthaphæreses *of the Moon.*

	Sign 0.			Sign 1.			Sign 2.			
		Add			Add			Add		
Deg. desc.	Moon's Eccen.	Variation. Mi.	Se.	Moon's Eccen.	Variation. Mi.	Se.	Moon's Eccent.	Variation. Mi.	Se.	Deg. asc.
0	0	0	00	1125	20	15	2174	35	04	30
1	38	0	43	1162	20	51	2207	35	25	29
2	76	1	26	1198	21	27	2240	35	45	28
3	114	2	08	1235	22	03	2272	36	05	27
4	152	2	50	1271	22	38	2304	36	24	26
5	190	3	32	1307	23	13	2336	36	42	25
6	228	4	14	1344	23	48	2368	37	00	24
7	265	4	56	1380	24	22	2400	37	17	23
8	303	5	38	1416	24	56	2432	37	33	22
9	341	6	20	1451	25	29	2463	37	48	21
10	379	7	02	1487	26	02	2494	38	03	20
11	417	7	44	1523	26	34	2525	38	17	19
12	454	8	26	1558	27	06	2556	38	30	18
13	492	9	07	1594	27	39	2587	38	42	17
14	530	9	48	1629	28	08	2617	38	55	16
15	568	10	29	1664	28	38	2647	39	07	15
16	605	11	10	1699	29	08	2677	39	18	14
17	643	11	51	1734	29	37	2707	39	28	13
18	680	12	31	1769	30	06	2737	39	37	12
19	718	13	11	1804	30	34	2766	39	45	11
20	755	13	51	1838	31	01	2795	39	53	10
21	792	14	31	1872	31	28	2824	40	00	9
22	830	15	10	1906	31	55	2853	40	06	8
23	867	15	49	1940	32	21	2881	40	12	7
24	904	16	28	1974	32	46	2909	40	17	6
25	941	17	07	2008	33	11	2937	40	21	5
26	978	17	45	2042	33	35	2965	40	25	4
27	1015	18	23	2075	33	58	2993	40	27	3
28	1052	19	01	2108	34	21	3021	40	28	2
29	1089	19	38	2141	34	43	3048	40	29	1
30	1125	20	15	2174	35	04	3075	40	30	0
		Subtract.			Subtract.			Subtract.		
	Sign 11.			Sign 10.			Sign 9.			

The Residue of Table XII.

The Second and Third Prosthaphæreses *of the Moon.*

Deg. desc.	*Sign 3.*			*Sign 4.*			*Sign 5.*			Deg. asc.
		Add			Add			Add		
	Moon's	*Variation.*		*Moon's*	*Variation.*		*Moon's*	*Variation.*		
	Eccen.	Mi.	Sc.	*Eccen.*	Mi.	Sc.	*Eccen.*	Mi.	Sc.	
0	3075	40	30	3765	35	04	4200	20	15	30
1	3102	40	29	3784	34	43	4210	19	38	29
2	3128	40	28	3803	34	21	4219	19	01	28
3	3154	40	27	3821	33	58	4228	18	23	27
4	3180	40	25	3839	33	35	4236	17	45	26
5	3206	40	21	3857	33	11	4245	17	07	25
6	3231	40	17	3874	32	46	4253	16	28	24
7	3256	40	12	3891	32	21	4261	15	49	23
8	3281	40	06	3908	31	55	4268	15	10	22
9	3306	40	00	3924	31	28	4275	14	31	21
10	3331	39	53	3940	31	01	4282	13	51	20
11	3355	39	45	3956	30	34	4288	13	11	19
12	3379	39	37	3972	30	06	4294	12	31	18
13	3403	39	28	3987	29	37	4300	11	51	17
14	3426	39	18	4002	29	08	4306	11	10	16
15	3449	39	07	4017	28	38	4311	10	29	15
16	3472	38	55	4031	28	08	4316	9	43	14
17	3495	38	43	4045	27	37	4320	9	07	13
18	3518	38	30	4059	27	06	4324	8	26	12
19	3540	38	17	4073	26	34	4328	7	44	11
20	3562	38	03	4086	26	02	4332	7	02	10
21	3584	37	48	4099	25	29	4335	6	20	9
22	3605	37	33	4111	24	56	4338	5	38	8
23	3626	37	17	4123	24	22	4340	4	56	7
24	3647	37	00	4135	23	48	4342	4	14	6
25	3667	36	42	4147	23	13	4344	3	32	5
26	3687	36	24	4158	22	38	4345	2	50	4
27	3707	36	05	4169	22	03	4346	2	08	3
28	3727	35	45	4180	21	27	4347	1	26	2
29	3746	35	25	4190	20	51	4348	0	43	1
30	3765	35	04	4200	20	15	4348	0	00	0
		Subtract.			*Subtract.*			*Subtract.*		
	Sign 8.			*Sign 7.*			*Sign 6.*			

TYCHO'S

LUNAR and SOLAR

TABLES.

TABLE XIII.

Epochæ, *or Roots, for the Meridian of* Friseland, *and at Midnight, which precedes the Kalends of* January.

Years of Christ.	*Epact.*				*Sun's Anomaly.*				*Moon.s Anom.*				*Motion of the Moon's Lat.*				*Sun's Motion.*			
	Da.	H.	M.	S.	Si.	De.	Mi.	Se.	Si.	De.	Mi.	Se.	Si.	De.	Mi.	Se.	Si.	De.	Mi.	Se.
1401	15	12	37	26	06	00	26	22	08	24	19	37	02	23	00	30	09	03	36	02
1501	11	04	24	35	06	04	14	20	05	09	33	55	07	12	26	58	09	08	39	04
1601	06	20	11	45	06	08	02	20	01	24	48	14	00	01	53	27	09	13	42	04
1701	02	11	59	00	06	11	50	20	10	10	02	28	04	21	19	55	09	18	45	05

TABLE XIV.

A Table of twenty extanded Years.

Absolute Years.	*Epact.*				*Sun's Anomaly.*				*Moon's Anom.*				*Motion of the Moon's Lat.*				*Sun's Motion.*			
	Da.	Ho.	Mi.	Se.	Si.	De.	Mi.	Se.	Si.	De.	Mi.	Se.	Si.	De.	Mi.	Se.	Si.	De.	Mi.	Se.
1	10	15	11	22	11	19	16	08	10	09	48	01	00	08	02	47	11	19	16	52
2	21	06	22	45	11	08	32	16	08	19	36	01	00	16	05	33	11	08	33	43
3	02	08	50	04	11	26	54	44	07	25	13	02	01	24	48	34	11	26	56	59
4	14	09	01	26	11	16	10	52	06	05	01	03	02	02	51	21	11	16	13	51
5	24	15	12	48	11	05	17	00	04	14	49	04	02	10	54	08	11	05	30	42
6	05	17	40	07	11	23	49	29	03	20	26	05	03	19	37	08	11	23	53	58
7	16	08	51	30	11	13	05	37	02	00	14	05	03	27	39	55	11	13	10	50
8	28	00	02	52	11	02	21	45	00	10	02	06	04	05	42	42	11	02	27	42
9	09	02	30	11	11	20	44	13	11	15	39	07	05	14	25	42	11	20	50	57
10	19	17	41	33	11	10	00	21	09	25	27	08	05	22	28	29	11	10	07	49
11	00	20	08	52	11	28	22	50	09	01	04	08	07	01	11	30	11	28	31	05
12	12	11	20	15	11	17	38	58	07	10	52	09	07	09	14	16	11	17	47	57
13	23	02	31	37	11	06	55	06	05	20	40	10	07	17	17	03	11	07	04	48
14	04	04	58	56	11	25	17	34	04	26	17	11	08	26	00	04	11	25	28	04
15	14	20	10	18	11	14	33	42	03	06	05	12	09	04	02	51	11	14	44	56
16	26	11	21	41	11	03	49	50	01	15	53	12	09	12	05	37	11	04	01	47
17	07	13	49	00	11	22	12	19	00	21	30	13	10	20	48	38	11	22	25	03
18	18	05	00	22	11	11	28	26	11	01	18	14	10	28	51	25	11	11	41	55
19	28	20	11	44	11	00	44	34	09	11	06	15	11	06	54	12	11	00	58	46
20	10	22	39	03	11	19	07	03	08	16	48	16	00	15	37	12	11	19	22	03
40	21	21	18	08	11	08	14	07	05	03	26	30	01	01	14	24	11	08	44	05
60	03	07	13	07	11	26	27	30	02	15	58	48	02	17	31	50	11	27	12	33
80	14	05	52	12	11	15	34	33	11	02	42	04	03	03	09	02	11	16	34	36

TABLE XV.

A Table of Months in a common Year.

Years of Christ.	*Epacts.* Da.	Ho.	Mi.	Se.	*Sun's Anomaly.* Si.	De.	Mi.	Se.	*Moon's Anom.* Si.	De	Mi.	Se.	*Motion of the Moon's Lat.* Si.	De.	Mi.	Se.	*Sun's Motion.* Si.	De.	Mi.	Se.
January	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Febru.	01	11	15	57	00	29	06	21	00	25	49	00	01	00	40	14	00	29	06	24
March	29	11	15	57	00	29	06	21	00	25	49	00	01	00	40	14	00	29	06	24
April	01	09	47	51	02	27	19	02	02	17	27	00	03	02	00	42	02	27	19	13
May	01	21	03	47	03	26	25	23	03	13	16	00	04	02	40	56	03	26	25	37
June	03	08	19	44	04	25	31	43	04	09	05	00	05	03	21	09	04	25	32	02
July	03	19	35	41	05	24	38	04	05	04	54	00	06	04	01	23	05	24	38	26
August	05	06	51	38	06	23	44	25	06	00	43	00	07	04	41	37	06	23	44	50
Septem.	06	18	07	35	07	22	50	45	06	26	32	01	08	05	21	51	07	22	51	14
October	07	05	23	32	08	21	57	06	07	22	21	01	09	06	02	05	08	21	57	39
Novem.	08	16	39	29	09	21	03	27	08	18	10	01	10	06	42	19	09	21	04	03
Decem.	09	03	55	25	10	20	09	47	09	13	59	01	11	07	22	33	10	20	10	27
Years.	10	15	11	22	11	19	16	08	10	09	48	01	00	08	02	47	11	19	16	52

TABLE XVI.

The Canon of the Full and New Moons.

Syzyg.	*The Time from which the Epacts are subtracted.* Da.	H.	M.	S.	*Sun's Anomaly.* Si.	De.	Mi.	Se.	*Moon's Anom.* Si.	De.	Mi.	Se.	*Motion of the Moon's Lat.* Si.	De.	Mi.	Se.	*Sun's Motion.* Si.	De.	Mi.	Se.
Full ☾.	15	18	22	02	00	14	33	10	06	12	54	30	06	15	20	07	00	14	33	12
New ☾.	30	12	44	03	00	29	06	21	00	25	49	00	01	00	40	14	00	29	06	24
Full ☾.	45	07	06	05	01	13	39	31	07	08	43	30	07	16	00	21	01	13	39	36
New ☾.	60	01	28	06	01	28	12	41	01	21	38	00	02	01	20	28	01	28	12	48
Full ☾.	74	19	50	08	02	12	45	52	08	04	32	30	08	16	40	35	02	12	46	01
New ☾.	89	14	12	09	02	27	19	02	02	17	27	00	03	02	00	42	02	27	19	13

TABLE XVII.

A Table of Lunar Months.

Lunar Months.	*Time.* Da. Ho Mi. Se. Th.	*Sun's Anomaly.* Si. De. Mi. Se. Th.	*Moon's Anomaly.* Si. De. Mi. Se Th.	*Motion of the Moon's Latitude.* Si De Mi. Se. Th.	*Motion of the Sun from the Æquin.* Si. De. Mi. Se Th
1	029 12 44 03 09	00 29 06 20 40	00 25 49 00 04	01 00 40 13 54	00 29 06 24 18
2	059 01 28 06 17	01 28 12 41 19	01 21 38 00 07	02 01 20 27 47	01 28 12 48 36
3	088 14 12 09 26	02 27 19 01 59	02 17 27 00 11	03 02 00 41 41	02 27 19 12 54
4	118 02 56 12 35	03 26 25 22 38	03 13 16 00 15	04 02 40 55 35	03 26 25 37 12
5	147 15 40 15 43	04 25 31 43 18	04 09 05 00 19	05 03 21 09 29	04 25 32 01 31
6	177 04 24 18 52	05 24 38 03 58	05 04 54 00 23	06 04 01 23 22	05 24 38 25 49
7	206 17 08 22 01	06 23 44 24 37	06 00 43 00 26	07 04 41 37 16	06 23 44 50 07
8	236 05 52 25 09	07 22 50 45 17	06 26 32 00 30	08 05 21 51 10	07 22 51 14 25
9	265 18 36 28 18	08 21 57 05 57	07 22 21 00 34	09 06 02 05 03	08 21 57 38 43
10	295 07 20 31 27	09 21 03 26 36	08 18 10 00 38	10 06 42 18 56	09 21 04 03 01
11	324 20 04 34 35	10 20 09 47 16	09 13 59 00 41	11 07 22 32 51	10 20 10 27 19
12	354 08 48 37 44	11 19 16 07 56	10 09 48 00 45	00 08 02 46 45	11 19 16 51 37
13	383 21 32 40 53	00 18 22 28 35	11 05 37 00 49	01 08 43 00 38	00 18 23 15 56

The half Month and Quadrant.

½	014 18 22 01 34	00 14 33 10 20	06 12 54 30 02	06 15 20 06 57	00 14 33 12 09
½	007 09 11 00 47	00 07 16 35 10	03 06 27 15 01	03 07 40 03 28	00 07 16 36 04

TABLE. XVIII.

The Reduction of the Moon to the Ecliptick.

	Subtract.						
	Sign 0.		*Sign* 1.		*Sign* 2.		
Degrees.	*Sign* 6.		*Sign* 7.		*Sign* 8.		*Degrees.*
	Min.	Sec.	Min.	Sec.	Min.	Sec.	
0	00	00	06	06	06	05	30
1	00	15	06	12	05	57	29
2	00	30	06	18	05	48	28
3	00	45	06	24	05	39	27
4	00	59	06	29	05	30	26
5	01	13	06	35	05	21	25
6	01	27	06	40	05	12	24
7	01	42	06	44	05	01	23
8	01	56	06	47	04	51	22
9	02	10	06	51	04	40	21
10	02	24	06	54	04	29	20
11	02	38	06	56	04	18	19
12	02	52	06	57	04	07	18
13	03	06	06	58	03	55	17
14	03	19	06	59	03	42	16
15	03	32	07	00	03	31	15
16	03	43	06	59	03	18	14
17	03	56	06	58	03	05	13
18	04	08	06	57	02	51	12
19	04	19	06	56	02	38	11
20	04	30	06	54	02	23	10
21	04	41	06	51	02	09	9
22	04	52	06	47	01	55	8
23	05	02	06	44	01	41	7
24	05	13	06	40	01	26	6
25	05	22	06	35	01	12	5
26	05	31	06	28	00	58	4
27	05	40	06	25	00	45	3
28	05	49	06	17	00	30	2
29	05	58	06	11	00	15	1
30	06	06	06	05	00	00	0
	Sign 11.		*Sign* 10.		*Sign* 9.		
	Sign 5.		*Sign.* 4.		*Sign* 3.		
	Add.						

TABLE XIX.

The Prosthaphæreses *or* Equations *of the* Nodes *of the* Moon.

Degrees	Sign 0 and 6, Equations Add			Scruples propor.		Sign 1 and 7, Equations Add			Scrup. propor.		Sign 2 and 8, Equations Add			Scrup. propor.		Degrees
	De.	Mi.	Se.	Mi.	Se.	De.	Mi.	Se.	Mi.	Se.	De.	Mi.	Se.	Mi.	Se.	
0	0	00	00	00	00	1	33	28	15	22	1	30	32	45	20	30
1	0	03	50	00	01	1	35	12	16	18	1	28	34	46	13	29
2	0	07	39	00	04	1	36	47	17	15	1	26	30	47	05	28
3	0	11	27	00	09	1	38	12	18	13	1	24	21	47	54	27
4	0	15	14	00	16	1	39	31	19	11	1	22	06	48	43	26
5	0	19	00	00	26	1	40	42	20	10	1	19	45	49	31	25
6	0	22	46	00	41	1	41	45	21	09	1	17	18	50	19	24
7	0	26	29	00	56	1	42	44	22	09	1	14	46	51	04	23
8	0	30	09	01	13	1	43	38	23	10	1	12	09	51	47	22
9	0	33	47	01	32	1	44	29	24	11	1	09	27	52	28	21
10	0	37	23	01	53	1	45	08	25	13	1	06	41	53	08	20
11	0	40	56	02	16	1	45	34	26	16	1	03	49	53	46	19
12	0	44	26	02	41	1	45	50	27	19	1	00	51	54	23	18
13	0	47	52	03	08	1	45	56	28	22	0	57	50	54	59	17
14	0	51	14	03	38	1	45	59	29	25	0	54	47	55	33	16
15	0	54	32	04	10	1	46	00	30	28	0	51	42	56	06	15
16	0	57	47	04	43	1	45	53	31	30	0	48	32	56	36	14
17	1	00	46	05	18	1	45	36	32	33	0	45	18	57	03	13
18	1	04	00	05	54	1	45	13	33	35	0	42	00	57	28	12
19	1	06	59	06	32	1	44	41	34	37	0	38	40	57	52	11
20	1	09	53	07	12	1	44	00	35	39	0	35	18	58	14	10
21	1	12	42	07	54	1	43	10	36	41	0	31	53	58	35	9
22	1	15	25	08	38	1	42	14	37	42	0	28	26	58	53	8
23	1	18	02	09	24	1	41	10	38	43	0	24	57	59	09	7
24	1	20	33	10	13	1	39	59	39	43	0	21	26	59	22	6
25	1	22	58	11	02	1	38	42	40	41	0	17	54	59	33	5
26	1	25	16	11	51	1	37	18	41	38	0	14	21	59	43	4
27	1	27	28	12	41	1	35	46	42	35	0	10	46	59	50	3
28	1	29	34	13	33	1	34	08	43	31	0	07	11	59	55	2
29	1	31	34	14	27	1	32	23	44	26	0	03	36	59	58	1
30	1	33	28	15	22	1	30	32	45	20	0	00	00	60	00	0
	Sign 11 and 5, Subtract					Sign 10 and 4, Subtract					Sign 9 and 3, Subtract					

TABLE XX.

A Table of the Moon's Latitude.

	Sign 0 North					Sign 1 North					Sign 2 North					
	Sign 6 South					Sign 7 South					Sign 8 South					
	Moon's Lat.			Excess		Moon's Lat.			Excess		Moon's Lat.			Excess		
Deg.	De.	Mi.	Se.	M.	S.	De.	Mi.	Se.	M.	S.	De.	Mi.	Se.	Mi.	Se.	
0	00	00	00	00	00	02	29	06	09	28	04	18	26	16	25	30
1	00	05	13	00	20	02	33	36	09	45	04	20	59	16	35	29
2	00	10	25	00	40	02	38	03	10	02	04	23	28	16	45	28
3	00	15	36	00	59	02	42	26	10	28	04	25	53	16	55	27
4	00	20	47	01	19	02	46	46	10	35	04	28	13	17	04	26
5	00	25	58	01	39	02	51	04	10	51	04	30	28	17	12	25
6	00	31	09	01	59	02	55	19	11	07	04	32	38	17	20	24
7	00	36	19	02	19	02	59	30	11	23	04	34	43	17	28	23
8	00	41	29	02	38	03	03	38	11	39	04	36	43	17	36	22
9	00	46	38	02	57	03	07	47	11	55	04	38	38	17	43	21
10	00	51	46	03	17	03	11	44	12	11	04	40	27	17	51	20
11	00	56	53	03	36	03	15	42	12	26	04	42	11	17	58	19
12	01	01	59	03	55	03	19	36	12	41	04	43	50	18	05	18
13	01	07	04	04	15	03	23	26	12	56	04	45	23	18	12	17
14	01	12	08	04	34	03	27	13	13	10	04	46	52	18	18	16
15	01	17	10	04	53	03	30	56	13	24	04	48	18	18	23	15
16	01	22	11	05	13	03	34	35	13	38	04	49	35	18	27	14
17	01	27	10	05	32	03	38	10	13	52	04	50	49	18	31	13
18	01	32	08	05	51	03	41	42	14	05	04	51	58	18	34	12
19	01	37	04	06	10	03	45	07	14	18	04	53	00	18	38	11
20	01	41	58	06	29	03	48	30	14	31	04	53	57	18	42	10
21	01	46	51	06	47	03	51	52	14	44	04	54	49	18	45	9
22	01	51	41	07	06	03	55	09	14	57	04	55	36	18	48	8
23	01	56	30	07	24	03	58	19	15	09	04	56	17	18	51	7
24	02	01	17	07	42	04	01	23	15	21	04	56	52	18	53	6
25	02	06	01	08	00	04	04	24	15	32	04	57	22	18	55	5
26	02	10	43	08	18	04	07	21	15	43	04	57	46	18	56	4
27	02	15	23	08	35	04	10	15	15	54	04	58	05	18	57	3
28	02	20	00	08	53	04	13	05	16	05	04	58	18	18	58	2
29	02	24	34	09	11	04	15	49	16	15	04	58	26	18	59	1
30	02	29	06	09	28	04	18	26	16	25	04	58	30	19	00	0
	Sign 11 South					Sign 10 South					Sign 9 South					Deg.
	Sign 5 North					Sign 4 North					Sign 3 North					

TABLE XXI.

A Table of the Parallaxes of the Sun and Moon in the vertical Circle.

Semidiametres		*The Moon.*										
		52	53	54	55	56	57	58	59	60	61	
Degrees of Altitude.	*Sun* Min.	92028 Mi.	93798 Mi.	95568 Mi.	97337 Mi.	99107 Mi.	100877 Mi.	102647 Mi.	104416 Mi.	106186 Mi.	107956 Mi.	*The Moon's Distance.*
0	3	66	65	64	63	61	60	59	58	57	56	
3	3	66	65	64	62	61	60	59	58	57	56	
6	3	66	65	63	62	61	60	59	58	57	56	
9	3	65	64	63	62	61	60	59	58	57	56	
12	3	65	64	62	61	60	59	58	57	56	55	
15	3	64	63	62	61	60	59	58	57	56	55	
18	3	63	62	61	60	59	58	57	56	55	54	
21	3	62	61	60	59	58	57	56	55	54	53	
24	3	61	60	59	58	56	55	54	54	53	52	
27	3	60	58	57	56	55	54	53	52	51	51	
30	3	58	57	56	55	54	53	52	51	50	49	
33	3	56	55	54	53	52	51	50	49	48	48	
36	2	54	53	52	51	50	49	48	48	47	46	
39	2	52	51	50	49	48	47	47	46	45	44	
42	2	50	49	48	47	46	45	45	44	43	42	
45	2	47	46	46	45	44	43	42	42	41	40	
48	2	45	44	43	42	42	41	40	39	39	38	
51	2	42	41	41	40	39	38	38	37	37	36	
54	2	40	39	38	37	37	36	35	35	34	34	
57	2	37	36	35	35	34	33	33	32	32	31	
60	2	34	33	32	32	31	31	30	30	29	29	
63	1	31	30	29	29	28	28	27	27	26	26	
66	1	27	27	26	26	25	25	25	24	24	23	
69	1	24	24	23	23	22	22	22	21	21	20	
72	1	21	20	20	20	19	19	19	18	18	18	
75	1	17	17	17	16	16	16	16	15	15	15	
78	1	14	14	13	13	13	13	13	12	12	12	
81	0	11	10	10	10	10	10	9	9	9	9	
84	0	7	7	7	7	7	6	6	6	6	6	
87	0	4	3	3	3	3	3	3	3	3	3	
90	0	0	0	0	0	0	0	0	0	0	0	

In this Table I have purposely omitted the Seconds, because they are wont to cause more trouble than the thing it self is worth.

TABLE XXII.

A Table of the Refractions of the Sun and Moon.

Degrees of Altitude.	Refractions Of the Sun. Min.	Refractions Of the Moon. Min.	Degrees of Altitude.	Refractions Of the Sun. Min.	Refractions Of the Moon. Min.
0	34	33	21	04	05
1	26	25	22	03	05
2	20	20	23	03	04
3	17	17	24	03	04
4	15	15	25	02	03
5	14	14	26	02	03
6	13	14	27	02	03
7	13	13	28	02	02
8	11	12	29	02	02
9	10	11	30	01	02
10	10	11	31	01	01
11	09	10	32	01	01
12	09	10	33	01	01
13	08	09	34	01	01
14	08	08	35	01	01
15	07	08	36	01	01
16	07	07	37	00	01
17	06	07	38	00	01
18	06	06	39	00	00
19	05	06	40	00	00
20	04	05	41	00	00

TABLE. XXIII.

A Table of the Apparent Semediametres.

The middle Anomaly of the Sun shews the Semidiametre of the Sun, with the Variation of the Shadow. The co-equall'd Anomaly of the Moon gives the Semidiametre of the Moon, and the Semidiametre of the Shadow, from which the Variation is taken.

Anomaly of the ⊙ or ☾.		*Of the Sun.*		*Of the Full ☾.*		*Of the New ☾.*		*Of the Shadow.*		*Variat.*	*Anomaly of the ⊙. or ☾.*	
Si.	De.	Mi.	Se.	Mi.	Se.	Mi.	Se.	Mi.	Se.	Se.	Si.	De.
00	00	15	00	16	00	12	48	43	00	00	12	00
00	06	15	00	16	00	12	48	43	01	00	11	24
00	12	15	01	16	01	12	49	43	02	01	11	18
00	18	15	02	16	03	12	50	43	06	02	11	12
00	24	15	03	16	05	12	52	43	09	03	11	06
01	00	15	04	16	08	12	54	43	14	04	11	00
01	06	15	06	16	12	12	58	43	19	06	10	24
01	12	15	08	16	16	13	01	43	25	09	10	18
01	18	15	10	16	21	13	05	43	33	12	10	12
01	14	15	12	16	25	13	08	43	41	15	10	06
02	00	15	15	16	30	13	12	43	49	18	10	00
02	06	15	18	16	36	13	17	43	58	21	09	24
02	12	15	21	16	42	13	22	44	09	24	09	18
02	18	15	24	16	48	13	26	44	20	27	09	12
02	24	15	26	16	54	13	31	44	31	30	09	06
03	00	15	29	17	00	13	35	44	43	34	09	00
03	06	15	32	17	05	13	41	44	55	37	08	24
03	12	15	35	17	12	13	46	45	07	40	08	18
03	18	15	38	17	17	13	50	45	19	43	08	12
03	24	15	41	17	22	13	54	45	31	46	08	06
04	00	15	43	17	26	13	57	45	44	49	08	06
04	06	15	46	17	31	14	01	45	56	51	07	24
04	12	15	49	17	36	14	05	46	07	52	07	18
04	18	15	51	17	41	14	09	46	17	53	07	12
04	24	15	53	17	46	14	13	46	27	54	07	06
05	00	15	55	17	50	14	16	46	36	55	07	00
05	06	15	57	17	54	14	19	46	44	55	06	24
05	12	15	58	17	57	14	22	46	50	55	06	18
05	18	15	59	17	58	14	22	46	55	56	06	12
05	24	15	59	17	59	14	23	46	58	56	06	06
06	00	16	00	18	00	14	24	47	00	56	06	00

TABLE XXIV.

A Table of the true horary Motion of the Moon in the true Syzygies, and half a day before and after the Syzygies.

Anomalies.

Deg.	*Sign* 0. *In the true Syz.* Min.	Sec.	*Before and after the Syz.* Min.	Sec.	*Sign* 1. *In the true Syz.* Min.	Sec.	*Before and after the Syz.* Min.	Sec.	*Sign* 2. *In the true Syz.* Min.	Sec.	*Before and after the Syz.* Min.	Sec.	Deg.
0	27	43	27	12	28	04	27	34	29	01	28	46	30
3	27	44	27	12	28	08	27	39	29	09	28	57	27
6	27	45	27	13	28	13	27	45	29	17	29	08	24
9	27	45	27	14	28	18	27	51	29	25	29	19	21
12	27	47	27	15	28	23	27	58	29	33	[illegible]	[illegible]	18
15	27	48	27	16	28	29	28	05	29	41	29	41	15
18	27	51	27	19	28	35	28	12	29	49	29	52	12
21	27	53	27	22	28	41	28	20	29	58	30	04	9
24	27	57	27	26	28	47	28	29	30	06	30	17	6
27	28	00	27	30	28	54	28	38	30	15	30	29	3
30	28	04	27	34	29	01	28	46	30	24	30	42	0
	Sign 11.				*Sign* 10.				*Sign* 9.				

Anomalies.

Deg.	*Sign* 3. *In the true Syz.* Min.	Sec.	*Before and after the Syz.* Min.	Sec.	*Sign* 4. *In the true Syz.* Min.	Sec.	*Before and after the Syz.* Min.	Sec.	*Sign* 5. *In the true Syz.* Min.	Sec.	*Before and after the Syz.* Min.	Sec.	Deg.
0	30	24	30	42	31	51	32	53	32	58	34	45	30
3	30	33	30	55	31	58	33	05	33	03	34	53	27
6	30	41	31	07	32	06	33	18	33	07	35	00	24
9	30	50	31	20	32	14	33	30	33	11	35	08	21
12	30	58	31	33	32	21	33	41	33	14	35	14	18
15	31	07	31	46	32	28	33	54	33	17	35	18	15
18	31	17	32	00	32	35	34	05	33	20	35	24	12
21	31	26	32	15	32	41	34	17	33	21	35	29	9
24	31	34	32	28	32	47	34	26	33	23	35	32	6
27	31	43	32	41	32	53	34	36	33	24	35	34	3
30	31	51	32	53	32	58	34	45	33	24	35	37	0
	Sign 8.				*Sign* 7.				*Sign* 6.				

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RUDOLPHUS'S TABLES,

Calculated in Decimal Parts of a Circle and Degrees.

TABLE XXV.

The Epochæ *of the middle Motions of the Sun and fixed Stars in the Years of the* Julian *Period, according to the Meridian of* Urenburgh, *in the Kalends of* January, *and the Midday of Astronomical Time,* Julian *Account.*

Mid. Mot. of the Sun from the Æquinox,		*Mid. Mot. of the Sun's Apogee from the* Æquin.			*Mid. Mot. of the first Star of* ♈. *from the* Æquinox.		
The Periodical Year according to the Julian *account.*	*Decimal parts of a Circle.*	*The Periodical Year according to the* Julian *account.*	*Signs,*	*Degrees of decimal parts.*	*The Periodical Year according to the* Julian *account.*	*Signs,*	*Degrees of decimalparts.*
0	6735528	0	11	17.6658	0	01	28.1825
1000	6945435	1000	00	4.7844	1000	10	12.3492
2000	7155342	2000	00	21.9031	2000	10	26.5158
3000	7365250	3000	01	9.0217	3000	11	10.6825
4000	7575157	4000	01	26.1403	4000	11	24.8492
5000	7785065	5000	02	13.2589	5000	00	9.0158
6000	7994972	6000	03	0.3775	6000	00	23.1825
		The Logarithm of the mid. Mot. of the Sun's Apogee in the Tropical Year. 2,23346.17			*The Logarithm of the mid. Motion of the fixed Stars in the Tropical Year.* 2,15126.24		

TABLE XXVI.

The middle Motion of the Sun from Aries *in the expanded Years, Months, Days, Hours, and Scruples.*

Mid. Mot. of the Sun from the Æquinox *in expanded Years.*		*Mid. Motion of the Sun from the* Æqu. *in the Months of a common Year.*		*Middle Motion of the Sun from the* Æquinox *in Days.*	
Years.	*Decimal parts of a Circle.*	*Months compleat.*	*Decimal parts of a Circle.*	*Days compl.*	*Decimal parts of a Circle.*
B 1	0020744	*January*	0848752	1	0023379
2	0014109	*Febru.*	1615366	2	0054758
3	0007474	*March*	2464117	3	0082137
4	0000840	*April*	3285490	4	0109516
B 5	0021584	*May*	4134241	5	0136895
6	0014949	*June*	4955614	6	0164274
7	0008314	*July*	5804366	7	0191654
8	0001679	*August*	6653117	8	0219033
B 9	0022423	*Septem.*	7474490	9	0246412
10	0015789	*October*	8323241	10	0273791
11	0009154	*Novem.*	9144614	11	0301170
12	0002519	*Decem.*	9993365	12	0328549
B 13	0023263			13	0355928
14	0016628	*Mid. Mot. ☉. from the Æq. in the Months of a bissextile Year.*		14	0383307
15	0009993			15	0410686
16	0003359	*January*	0848752	16	0438065
B 17	0024103	*Febru.*	1642745	17	0465444
18	0017468	*March*	2491497	18	0492823
19	0010833	*April*	3312869	19	0520203
20	0004198	*May*	4161621	20	0547582
40	0008396	*June*	4982993	21	0574961
60	0012594	*July*	5831745	22	0602340
80	0016793	*August*	6680496	23	0629719
100	0020991	*Septem.*	7501869	24	0657098
200	0041981	*October*	8350620	25	0684477
300	0062972	*Novem.*	9171993	26	0711856
400	0083963	*Decem.*	1.0020744	27	0739235
500	0104954			28	0766614
600	0125944	Note, That the Table of expanded Years agrees only with the Epoch. in the year of the *Julian* Period, in which year 1, 5, 9, 13, 17, above the Complement of twenty or an hundred, are bissext.		29	0793993
600	0146935			30	0821372
800	0167926			31	0848752
900	0188917				
1000	0209907				

The Residue of Table XXVI.

The middle Motion of the Sun from Aries *in the expanded Years, Months, Days, Hours, and Scruples.*

Mid. Mot. of the Sun from the Æquinox *in Hours.*		*Mid. Motion of the Sun from the* Æqu. *in Minutes.*		*Middle Motion of the Sun from the* Æquinox *in Minutes.*	
Hours.	*Decimal parts of a Circle.*	*Minut.*	*Decimal parts of a Circle.*	*Minut.*	*Decimal parts of a Circle.*
1	0001141	1	0000190	31	0005894
2	0002282	2	0000380	32	0006084
3	0003422	3	0000570	33	0006274
4	0004563	4	0000761	34	0006465
5	0005704	5	0000951	35	0006655
6	0006845	6	0001141	36	0006845
7	0007986	7	0001331	37	0007035
8	0009126	8	0001521	38	0007225
9	0010267	9	0001711	39	0007415
10	0011408	10	0001901	40	0007605
11	0012549	11	0002091	41	0007796
12	0013690	12	0002282	42	0007986
13	0014830	13	0002472	43	0008176
14	0015971	14	0002662	44	0008366
15	0017112	15	0002852	45	0008556
16	0018253	16	0003042	46	0008746
17	0019394	17	0003232	47	0008936
18	0020534	18	0003422	48	0009126
19	0021675	19	0003613	49	0009317
20	0022816	20	0003803	50	0009507
21	0023957	21	0003993	51	0009697
22	0025097	22	0004183	52	0009887
23	00 6238	23	0004373	53	0010077
24	0027379	24	0004563	54	0010267
		25	0004753	55	0010457
		26	0004943	56	0010648
		27	0005134	57	0010838
		28	0005324	58	0011028
		29	0005514	59	0011218
		30	0005704	60	0011408

TABLE XXVII.

A Table of the Conversion of the decimal parts of a Circle into Degrees, and decimal parts of Degrees.

Decimal parts of a Circle. (1) (2) (3) (4) (5) (6)	Degrees or decimal parts of Degrees. 210.1 0.123 0.12345	Decimal parts of a Circle. (1) (2) (3) (4) (5) (6)	Degrees or decimal parts of Degrees. 210.1 0.123 0.12345	Decimal parts of a Circle. (1) (2) (3) (4) (5) (6)	Degrees, or decimal parts of Degrees. 210.1 0.123 0.12345
01	0036	34	1224	67	2412
02	0072	35	1260	68	2448
03	0108	36	1296	69	2484
04	0144	37	1332	70	2520
05	0180	38	1368	71	2556
06	0216	39	1404	72	2592
07	0252	40	1440	73	2628
08	0288	41	1476	74	2664
09	0324	42	1512	75	2700
10	0360	43	1548	76	2736
11	0396	44	1584	77	2772
12	0432	45	1620	78	2808
13	0468	46	1656	79	2844
14	0504	47	1692	80	2880
15	0540	48	1728	81	2916
16	0576	49	1764	82	2952
17	0612	50	1800	83	2988
18	0648	51	1836	84	3024
19	0684	52	1872	85	3060
20	0720	53	1908	86	3096
21	0756	54	1944	87	3132
22	0792	55	1980	88	3168
23	0828	56	2016	89	3204
24	0864	57	2052	90	3240
25	0900	58	2088	91	3276
26	0936	59	2124	92	3312
27	0972	60	2160	93	3348
28	1008	61	2196	94	3384
29	1044	62	2232	95	3420
30	1080	63	2268	96	3456
31	1116	64	2304	97	3492
32	1152	65	2340	98	3528
33	1188	66	2376	99	3564

TABLE XXVIII.

A Table of the Equation of the Centre of the Sun.

	Subtract.						
	Sign 0.		*Sign* 1.		*Sign* 2.		
Degrees.	De. dec. p.	Log. di.	De. dec. p.	Log. di.	De. dec. p.	Log. di.	Degrees.
0	00.0000	400775	01.0114	400677	01.7667	400398	30
1	00.0353	400775	01.0419	400668	01.7847	400389	29
2	00.0706	400775	01.0717	400659	01.8022	400376	28
3	00.1058	400775	01.1019	400655	01.8192	400363	27
4	00.1406	400775	01.1317	400647	01.8358	400350	26
5	00.1758	400771	01.1619	400638	01.8517	400342	25
6	00.2106	400771	01.1897	400634	01.8669	400329	24
7	00.2453	400771	01.2181	400625	01.8819	400316	23
8	00.2806	400766	01.2464	400617	01.8961	400303	22
9	00.3158	400766	01.2747	400608	01.9122	400290	21
10	00.3506	400762	01.3025	400599	01.9239	400277	20
11	00.3856	400762	01.3303	400591	01.9356	400264	19
12	00.4200	400758	01.3567	400582	01.9475	400252	18
13	00.4547	400753	01.3833	400574	01.9592	400238	17
14	00.4919	400751	01.4097	400565	01.9703	400225	16
15	00.5236	460749	01.4353	400557	01.9806	400212	15
16	00.5606	400745	01.4603	400548	01.9903	400199	14
17	00.5906	400740	01.4850	400535	01.9992	400186	13
18	00.6181	400736	01.5194	400527	02.0078	400173	12
19	00.6581	400732	01.5336	400518	02.0156	400160	11
0	00.6917	400728	01.5569	400509	02.0225	400147	10
21	00.7244	400723	01.5805	400497	02.0292	400134	9
22	00.7575	400719	01.6031	400488	02.0358	400121	8
23	00.7883	400715	01.6256	400475	02.0414	400108	7
24	00.8219	400711	01.6497	400467	02.0467	400095	6
25	00.8542	400702	01.6675	400454	02.0506	400078	5
26	00.8861	400698	01.6900	400445	02.0542	400065	4
27	00.9178	400694	01.7094	400432	02.0572	400052	3
28	00.9503	400685	01.7292	400419	02.0597	400039	2
29	00.9794	400682	01.7483	400411	02.0614	400026	1
30	01.0114	400677	01.7667	400398	02.0625	400013	0
	Sign 11.		*Sign* 10.		*Sign* 9.		
	Add						

TABLE XXVIII.

A Table of the Equation of the Centre of the Sun.

Subtract							
Degrees.	Sign 3, D. dec. p.	Log.di.	Sign 4, D. dec. p.	Log.di.	Sign 5, D. dec. p.	Log.di.	Degrees.
0	02.0625	400013	01.8064	399616	01.0511	399321	30
1	02.0628	400000	01.7886	399607	01.0189	399313	29
2	02.0622	399987	01.7703	399594	00.9869	399308	28
3	02.0619	399974	01.7514	399585	00.9547	399299	27
4	02.0606	399961	01.7319	399572	00.9222	399295	26
5	02.0575	399943	01.7119	399559	00.8889	399290	25
6	02.0553	399930	01.6908	399550	00.8553	399282	24
7	02.0517	399917	01.6700	399537	00.8222	399277	23
8	02.0483	399904	01.6481	399524	00.7886	399273	22
9	02.0436	399891	01.6258	399515	00.7544	399269	21
10	02.0381	399874	01.6028	399506	00.7200	399264	20
11	02.0331	399865	01.5808	399493	00.6856	399260	19
12	02.0267	399852	01.5572	399480	00.6506	399255	18
13	02.0192	399835	01.5331	399471	00.6156	399250	17
14	02.0114	399822	01.5083	399462	00.5806	399246	16
15	02.0031	399808	01.4828	399449	00.5450	399242	15
16	01.9947	399795	01.4569	399441	00.5194	399238	14
17	01.9850	399782	01.4308	399432	00.4739	399233	13
18	01.9747	399769	01.4042	399423	00.4381	399229	12
19	01.9639	399756	01.3744	399412	00.4022	399226	11
20	01.9525	399743	01.3497	399401	00.3661	399224	10
21	01.9408	399730	01.3222	399392	00.3297	399224	9
22	01.9283	399717	01.2936	399383	00.2939	399220	8
23	01.9153	399704	01.2647	399378	00.2572	399220	7
24	01.9014	399695	01.2353	399367	00.2206	399220	6
25	01.8867	399682	01.2056	399360	00.1839	399216	5
26	01.8692	399669	01.1756	399352	00.1469	399216	4
27	01.8564	399656	01.1447	399344	00.1106	399216	3
28	01.8400	399642	01.1139	399335	00.0736	399216	2
29	01.8231	399629	01.0825	399326	00.0369	399216	1
30	01.8064	399616	01.0511	399321	00.0000	399216	0
	Sign 8,		Sign 7,		Sign 6,		
Add							

TABLE XXIX.

The Epochæ *of the middle Motions of* Saturn, *in the Years of the Julian Period, for the Meridian of* Urenburgh, *in the Kalends of* January, *the Mid-day of Astronomical Time, according to the Julian Account.*

Middle Motion of Saturn from the Æquinox.		*Middle Motion of the Aphelion of Saturn from the Æquinox.*			*Middle Mot. of the northern Node of Saturn from the Æquinox.*		
In a comp. Year of the Julian Period.	*Decimal parts of a Circle.*	*In a comp. Year of the Julian Period.*	*Signs.*	*Degrees with decimal parts.*	*In a comp. Year of the Julian Period.*	*Signs.*	*Degrees with decimal parts.*
0	026400	0	04	13.2536	0	11	25.7004
1000	012229	1000	05	4.2748	1000	00	5.5485
2000	998059	2000	05	25.2959	2000	00	25.3966
3000	983888	3000	06	16.3170	3000	01	15.2447
4000	969718	4000	07	7.3381	4000	02	5.0928
5000	955547	5000	07	28.3592	5000	02	24.9409
6000	941377	6000	08	19.3803	6000	03	14.7890
Logarithm of the mid. Mot. of Saturn *in the Tropical Year.* $\bar{1}$.53128.87		*Logarithm of the middle Motion of the Aphelion of* Saturn *in the Tropical Year.* $\bar{2}$.32268.65			*Logarithm of the middle Motion of the northern Node of* Saturn *in a Tropical Year.* $\bar{2}$.29771.49		

Middle Motion of Saturn *from the* Æquinox *in the Tropical Years.*	
Trop. Years	*Decimal parts of a Circle.* 0.12345.678
1	03398.512
2	06797.023
3	10195.535
4	13594.046
5	16992.558
6	20391.070
7	23789.581
8	27188.093
9	30586.604

The Bounds of the Stations of Saturn:

The Anomaly of the Eccentrick.	*The Angle of Commutation, or the Angle to the Sun.*			
	First.		*Second.*	
Sig.	Sig.De.	d. p. cir.	Sig.De.	d. p. cir.
00	03	23.80	03	23.95
03	03	25.45	03	24.78
06	03	26.88	03	26.83
09	03	24.62	03	25.33

TABLE XXX.

A Table of the Equation of the Centre of Saturn.

Subtract.

Degrees.	*Sign* 0. De.p.d.	Log. di.	*Sign* 1. De. p.d.	Log.di.	*Sign* 2. De.p.d.	Log. di.	Degrees.
0	00.0000	500223	03.0736	499939	05.4528	499136	30
1	00.1064	500223	03.1681	499920	05.5128	499101	29
2	00.2119	500222	03.2614	499900	05.5711	499067	28
3	00.3183	500220	03.3539	499880	05.6283	499031	27
4	00.4242	500218	03.4456	499859	05.6836	498996	26
5	00.5314	500214	03.5367	499838	05.7372	498960	26
6	00.6372	500211	03.6267	499817	05.7889	498923	24
7	00.7353	500207	03.7158	499794	05.8394	498886	23
8	00.8494	500202	03.8042	499772	05.8878	498849	22
9	00.9544	500197	03.8914	499747	05.9347	498812	21
10	01.0653	500191	03.9775	499724	05.9800	498774	20
11	01.1647	500184	04.0625	499696	06.0239	498736	19
12	01.2694	500173	04.1464	499675	06.0664	498697	18
13	01.3739	500169	04.2292	499649	06.1072	498658	17
14	01.4778	500160	04.3108	499623	06.1464	498619	16
15	01.5814	500151	04.3917	499596	06.1833	498580	15
16	0 .6844	500142	04.4708	499570	06.2183	498540	14
17	01.7872	500131	04.5486	499542	06.2517	498500	13
18	01.8894	500121	04.6256	499513	06.2831	498460	12
19	01.9919	500008	04.7014	499484	06.3131	498419	11
20	02.0928	500095	04.7753	499455	06.3411	498378	10
20	02.2100	500082	04.8483	499426	06.3669	498337	9
22	02.2939	500071	04.9206	499395	06.3911	498296	8
23	02.3933	500056	04.9942	499364	06.4133	498254	7
24	02.4925	500041	05.0611	499333	06.4336	498212	6
25	02.5908	500026	05.1297	499302	06.4522	498170	5
26	02.6889	500009	05.1972	499269	06.4686	498128	4
27	02.7864	499993	05.2636	499236	06.4842	498086	3
28	02.8828	499973	05.3281	499203	06.4978	498044	2
29	02.9786	499956	05.3914	499170	06.5092	498002	1
30	03.0736	499939	05.4528	491136	06.5183	497958	0
	Sig. 11.		*Sign* 10.		*Sign* 9.		

Add

The Residue of Table XXX.

A Table of the Equation of the Centre of Saturn.

Subtract,							
	Sign 3.		Sign 4.		Sign 5.		
Degrees.	De.p.d.	Log.di.	De.p.d.	Log.di.	De.p.d.	Log.di.	Degrees
0	06.5183	497958	05.8539	496677	03.4775	495662	30
1	06.5256	497916	05.8008	496637	03.3714	495637	29
2	06.5306	497873	05.7458	496596	03.2689	495614	28
3	06.5331	497829	05.6889	496557	03.1631	495590	27
4	06.5339	497787	05.6254	496517	03.0553	495568	26
5	06.5331	497744	05.5686	496478	02.9469	495547	25
6	06.5306	497700	05.5058	496439	02.8372	495525	24
7	06.5256	497657	05.4417	496401	02.7267	495505	20
8	06.5189	497613	05.3747	496364	02.6153	495485	22
9	06.5097	497570	05.3061	496327	02.5036	495466	21
10	06.4983	497526	05.2353	496390	02.3906	495449	20
11	06.4856	497482	05.1628	496254	02.2769	495432	19
12	06.4711	497439	05.0886	496217	02.1619	495416	18
13	06.4539	497396	05.0131	496181	02.0469	495400	17
14	06.4353	497352	04.9361	496143	01.9308	495386	16
15	06.4142	497309	04.8572	496112	01.8139	495372	15
16	06.3914	497266	04.7769	496077	01.6967	495359	14
17	06.3664	497223	04.6947	496044	01.5786	495347	13
18	06.3333	497180	04.6103	496011	01.4597	495336	12
19	06.3097	497137	04.5247	495978	01.3400	495326	11
20	06.2786	497094	04.4372	495946	01.2197	425317	10
21	06.2450	497051	04.3478	495914	01.0989	495308	9
22	06.2097	497009	04.2572	495883	00.9778	495301	8
23	06.1725	496967	04.1647	495854	00.8567	495294	7
24	06.1325	496925	04.0703	495824	00.7350	495288	6
25	06.0908	496882	03.9750	495796	00.6111	495283	5
26	06.0472	496841	03.8783	495767	00.4900	495279	4
27	06.0022	496799	03.7803	495740	00.3678	495276	3
28	05.9547	496758	03.6808	495713	00.2453	495273	2
29	05.9053	496715	03.5797	495688	00.1228	495272	1
30	05.8539	496677	03.4775	495662	00.0000	495272	0
	Sign 8.		Sign 7.		Sign 6.		
Add							

TABLE XXXI.

A Table of the Inclination of Saturn, *and of his Reduction to the Ecliptick.*

Degrees	Inclination.			Reduction, Subtract			Degrees
	Sign 0,	*Sign* 1,	*Sign* 2,	*Sign* 0,	*Sign* 1,	*Sign* 2,	
	Sign 6,	*Sign* 7,	*Sign* 8,	*Sign* 6,	*Sign* 7,	*Sign* 8,	
	D. dec. p.	D. dec. p.	D. dec. p.	D. dec. p.	D. dec. p.	D. dec. p.	
0	00.0000	01.2667	02.1942	00.0000	00.0242	00.0242	30
1	00.0442	01.3050	02.2161	00.0011	00.0247	00.0236	29
2	00.0883	01.3431	02.2375	00.0022	00.0250	00.0231	28
3	00.1325	01.3806	02.2581	00.0031	00.0256	00.0225	27
4	00.1767	01.4175	02.2778	00.0042	00.0261	00.0219	26
5	00.2206	01.4539	02.2967	00.0050	00.0264	00.0214	25
6	00.2644	01.4897	02.3147	00.0061	00.0267	00.0208	24
7	00.3083	01.5250	02.3322	00.0069	00.0269	00.0203	23
8	00.3519	01.5600	02.3492	00.0078	00.0272	00.0197	22
9	00.3956	01.5944	02.3653	00.0089	00.0272	00.0189	21
10	00.4389	01.6283	02.3806	00.0097	00.0275	00.0181	20
11	00.4819	01.6619	02.3953	00.0106	00.0275	00.0175	19
12	00.5250	01.6950	02.4092	00.0117	00.0278	00.0167	18
13	00.5681	01.7275	02.4222	00.0125	00.0278	00.0158	17
14	00.6108	01.7194	02.4347	00.0133	00.0281	00.0150	16
15	00.6536	01.7908	02.4464	00.0142	00.0281	00.0142	15
16	00.6961	01.8217	02.4575	00.0150	00.0281	00.0133	14
17	00.7386	01.8519	02.4678	00.0158	00.0278	00.0125	13
18	00.7808	01.8817	02.4775	00.0167	00.0278	00.0117	12
19	00.8228	01.9108	02.4864	00.0175	00.0275	00.0106	11
20	00.8644	01.9394	02.4947	00.0181	00.0275	00.0097	10
21	00.9061	01.9675	02.5022	00.0189	00.0272	00.0089	9
22	00.9475	01.9950	02.5089	00.0197	00.0272	00.0078	8
23	00.9886	02.0219	02.5147	00.0203	00.0269	00.0069	7
24	01.0292	02.0483	02.5197	00.0208	00.0267	00.0061	6
25	01.0697	02.0742	02.5239	00.0214	00.0264	00.0050	5
26	01.1097	02.0994	02.5275	00.0219	00.0261	00.0042	4
27	01.1494	02.1242	02.5303	00.0225	00.0256	00.0031	3
28	01.1889	02.1481	02.5322	00.0231	00.0250	00.0022	2
29	01.2281	02.1714	02.5333	00.0236	00.0247	00.0011	1
30	01.2667	02.1942	02.5333	00.0242	00.0242	00.0000	0
	Sign 11,	*Sign* 10,	*Sign* 9,	*Sign* 11,	*Sign* 10,	*Sign* 9,	
	Sign 5,	*Sign* 4,	*Sign* 3,	*Sign* 5,	*Sign* 4,	*Sign* 3,	
				Add			

TABLE XXIX.

The Epochæ *of the middle Motions of* Jupiter, *in the Years of the Julian Period, for the Meridian of* Urenburgh, *in the Kalends of* January, *the Mid-day of Astronomical Time, according to the Julian Account.*

Middle Motion of Jupiter *from the* Æquinox.		*Middle Motion of the Aphelion of* Jupiter *from the* Æquinox.			*Middle Mot. of the northern Node of* Jupiter *from the* Æquinox.		
In a comp. Year of the Julian Period.	*Decimal parts of a Circle.*	*In a comp. Year of the Julian Period.*	*Signs.*	*Degrees with decimal parts.*	*In a comp. Year of the Julian Period.*	*Signs.*	*Degrees with decimal parts.*
0	996112	0	03	14.1282	0	12	29.3005
1000	337982	1000	03	27.2343	1000	03	0.2719
2000	679851	2000	04	10.3404	2000	03	1.2433
3000	021721	3000	04	23.4465	3000	03	2.2147
4000	363590	4000	05	6.5526	4000	03	3.1861
5000	705460	5000	05	19.6588	5000	03	4.1575
6000	047330	6000	06	0.7649	6000	03	5.1289
Logarithm of the mid. Mot. of Jupiter *in the Tropical Year.* $\bar{1}$.92603.41		*Logarithm of the middle Motion of the Aphelion of* Jupiter *in the Tropical Year.* $\bar{2}$.11746.48			*Logarithm of the middle Motion of the northern Node of* Jupiter *in a Tropical Year.* $\bar{4}$.98735.64		

Middle Motion of Jupiter *from the* Æquinox *in the Tropical Years.*	
Trop. Years	*Decimal parts of a Circle.* 0.12345.678
1	08434.010
2	16868 020
3	25302.030
4	33736.040
5	42170.150
6	50604.060
7	59038.069
8	67472.079
9	75906.089

The Bounds of the Stations of Jupiter.

The Anomaly of the Eccentrick.	*The Angle of Commutation, or the Angle to the Sun.* *First.*		*Second.*	
Sig.	Sig.De.	d. p. cir.	Sig.De.	d. p. cir.
00	04	3.95	04	4.90
03	04	6.37	04	6.40
06	04	8.25	04	7.25
09	04	5.63	04	5.68

TABLE XXXIII.

A Table of the Equation of the Centre of Jupiter.

	Subtract.						
Degrees.	*Sign* 0.		*Sign* 1.		*Sign* 2.		Degrees.
	De. dec. p.	Log. di.	De. dec. p.	Log. di.	De. dec. p.	Log. di.	
0	00.0000	473645	02.6250	473400	04.6394	472706	30
1	00.0911	473645	02.7047	473385	04.6892	472677	29
2	00.1819	473644	02.7839	473366	04.7381	472648	28
3	00.2728	473642	02.8618	473349	04.7856	472616	27
4	00.3639	473640	02.9408	473331	04.8317	472586	26
5	00.4547	473639	03.0183	473312	04.8764	472555	25
6	00.5453	473636	03.0947	473294	04.9194	472524	24
7	00.6356	473631	03.1703	473272	04.9617	472485	23
8	00.7261	473626	03.2450	473255	05.0022	472462	22
9	00.8158	473620	03.3189	473235	05.0417	472429	21
10	00.9050	473615	03.3922	473214	05.0794	472397	20
11	00.9947	473609	03.4642	473193	05.1158	472368	19
12	01.0839	473605	03.5356	473169	05.1511	472331	18
13	01.1731	473599	03.6056	473148	05.1844	472296	17
14	01.2619	473592	03.6750	473126	05.2167	472263	16
15	01.3503	473584	03.7439	473102	05.2475	472230	15
16	0[illegible].4386	473575	03.8111	473079	05.2764	472197	14
17	01.5264	473565	03.8772	473056	05.3036	472162	13
18	01.6139	473556	03.9428	473031	05.3300	472127	12
19	01.7008	473546	04.0072	473006	05.3553	472093	11
20	01.7875	473536	04.0703	472981	05.3781	472058	10
21	01.8739	473524	04.1328	472955	05.3983	472023	9
22	01.9597	473513	04.1936	472929	05.4178	471988	8
23	02.0453	473500	04.2539	472903	05.4356	471953	7
24	02.1300	473487	04.3128	472875	05.4519	471917	6
25	02.2144	473474	04.3706	472848	05.4672	471883	5
26	02.2978	473460	04.4269	472821	05.4803	471847	4
27	02.3806	473446	04.4822	472792	05.4919	471810	3
28	02.4569	473431	04.5358	472764	05.5022	471774	2
29	02.5439	4734[illegible]7	04.5883	472735	05.5103	471737	1
30	02.6250	473400	04.6394	472706	05.5175	471700	0
	Sig. 11.		*Sign* 10.		*Sign* 9.		
	Add						

The Residue of Table XXXIII.

A Table of the Equation of the Centre of Jupiter.

	Subtract						
	Sign 3.		*Sign* 4.		*Sign* 5.		
Degrees.	De. dec. p.	Log. di.	De. dec. p.	Log. di.	De. dec. p.	Log. di.	Degrees.
0	05.5175	471704	04.9286	470621	02.9125	469776	30
1	05.5219	471667	04.8828	470587	02.8261	469755	29
2	05.5250	471631	04.8353	470554	02.7389	469736	28
3	05.5267	471594	04.7861	470519	02.6506	469717	27
4	05.5264	471558	04.7353	470487	02.5606	469698	26
5	05.5250	471521	04.6828	470455	02.4697	469680	25
6	05.5217	471484	04.6286	470423	02.3783	469663	24
7	05.5167	471445	04.5733	470390	02.2861	469645	23
8	05.5100	471406	04.5164	470358	02.1925	469630	22
9	05.5017	471372	04.4581	470327	02.0981	469615	21
10	05.4911	471336	04.3983	470297	02.0022	469600	20
11	05.4794	471299	04.3367	470266	01.9064	469586	19
12	05.4656	471262	04.2742	470236	01.8097	469572	18
13	05.4500	471225	04.2097	470207	01.7122	469560	17
14	05.4331	471188	04.1442	470177	01.6142	429547	16
15	05.4142	471152	04.0775	470149	01.5158	469536	15
16	05.3939	471116	04.0094	470121	01.4167	469526	14
17	05.3711	471079	03.9392	470092	11.3175	469516	13
18	05.3469	471043	03.8678	470065	11.2178	469507	12
19	05.3208	471007	03.7950	470037	11.1178	469499	11
20	05.2933	470970	03.7208	470012	01.0172	469491	10
21	05.2653	470935	03.6453	469986	00.9164	469484	9
22	05.2350	470899	03.5683	469960	00.8153	469478	8
23	05.2019	470863	03.4903	469934	00.7139	469472	7
24	05.1681	470828	03.4108	469910	00.6125	469468	6
25	05.1322	470793	03.3303	469887	00.5108	469463	5
26	05.0947	470759	03.2489	469863	00.4089	469460	4
27	05.0558	470724	03.1664	469841	00.3067	469457	3
28	05.0147	470689	03.0831	469819	00.2044	469455	2
29	04.9725	470655	02.9983	469797	00.1025	469454	1
30	04.9286	470621	02.9125	469776	00.0000	469453	0
	Sign 8.		*Sign* 7.		*Sign* 6.		
	Add						

TABLE XXXIV.

A Table of the Inclination of Jupiter, *and of his Reduction to the Ecliptick.*

	Inclination,			Reduction, Subtract,			
Degrees.	*Sign* 0, *Sign* 6, De. p. d.	*Sign* 1, *Sign* 7, De. p. d.	*Sign* 2, *Sign* 8, De. p. d.	*Sign* 0, *Sign* 6, De. p. d.	*Sign* 1, *Sign* 7, De. p. d.	*Sign* 2, *Sign* 8, De. p. d.	Degrees.
0	00.0000	00.6611	01.1953	00.0000	00.0067	00.0067	03
1	00.0231	00.6808	01.1564	00.0006	00.0069	00.0067	29
2	00.0461	00.7003	01.1672	00.0008	00.0069	00.0064	28
3	00.0692	00.7194	01.1778	00.0011	00.0072	00.0064	27
4	00.0922	00.7386	01.1878	00.0014	00.0072	00.0061	26
5	00.1153	00.7575	01.1978	00.0017	00.0072	00.0061	25
6	00.1383	00.7764	01.2072	00.0019	00.0075	00.0058	24
7	00.1611	00.7950	01.2164	00.0022	00.0075	00.0056	23
8	00.1842	00.8136	01.2253	00.0025	00.0075	00.0056	22
9	00.2069	00.8319	01.2339	00.0028	00.0078	00.0053	21
10	00.2297	00.8500	01.2422	00.0028	00.0078	00.0150	20
11	00.2525	00.8681	01.2503	00.0031	00.0078	00.0050	19
12	00.2750	00.8858	01.2578	00.0033	00.0078	00.0047	18
13	00.2975	00.9033	01.2650	00.0036	00.0078	00.0044	17
14	00.3200	00.9206	01.2717	00.0039	00.0078	00.0042	16
15	00.3422	00.9372	01.2778	00.0039	00.0071	00.0039	15
16	00.3642	00.6539	01.2836	00.0042	00.0078	00.0039	14
17	00.3867	00.9700	01.2889	00.0044	00.0078	00.0036	13
18	00.4086	00.9856	01.2936	00.0047	00.0078	00.0033	12
19	00.4306	01.0008	01.2981	00.0050	00.0078	00.0031	11
20	00.4522	01.0158	01.3019	00.0050	00.0078	00.0028	10
21	00.4739	01.0303	01.3056	00.0053	00.0078	00.0028	9
22	00.4953	01.0444	01.3086	00.0056	00.0075	00.0025	8
23	00.5167	01.0583	01.3114	00.0056	00.0075	00.0022	7
24	00.5378	01.0717	01.3139	00.0058	00.0075	00.0019	6
25	00.5589	01.0847	01.3161	00.0061	00.0072	00.0017	5
26	00.5797	01.0975	01.3181	00.0061	00.0072	00.0014	4
27	00.6003	01.1100	01.3197	00.0064	00.0072	00.0011	3
28	00.6208	01.1222	01.3211	00.0064	00.0069	00.0008	2
29	00.6411	01.1339	01.3219	00.0067	00.0069	00.0006	1
30	00.6611	01.1953	01.1453	00.0067	00.0067	00.0000	0
	Sign 11, *Sign* 5.	*Sign* 10, *Sign* 4,	*Sign* 9, *Sign* 3,	*Sign* 11, *Sign* 5,	*Sign* 10, *Sign* 4,	*Sign* 9, *Sign* 3,	
			Add				

TABLE XXXV.

The Epochæ *of the middle Motions of* Mars, *in the Years of the Julian Period, for the Meridian of* Urenburgh, *in the Kalends of* January, *the Mid-day of Astronomical Time, according to the Julian Account.*

Middle Motion of Mars *from the* Æquinox.		*Middle Motion of the Aphelion of* Mars *from the* Æquinox.			*Middle Mot. of the northern Node of* Mars *from the* Æquinox.		
In a comp. Year of the Julian Period.	*Decimal parts of a Circle.*	*In a comp. Year of the Julian Period.*	*Signs.*	*Degrees with decimal parts.*	*In a comp. Year of the Julian Period.*	*Signs.*	*Degrees with decimal parts.*
0	147958	0	01	1.6012	0	11	7.0439
1000	860996	1000	01	20.1973	1000	11	18.0844
2000	574035	2000	02	8.7934	2000	11	29.1248
3000	287073	3000	02	27.3895	3000	00	10.1652
4000	000112	4000	03	15.9856	4000	00	21.2058
5000	713150	5000	04	4.5817	5000	01	2.2462
6000	426188	6000	04	23.1778	6000	01	13.2867
Logarithm of the mid. Mot. of Mars *in the Tropical Year.* 1.72566.83		*Logarithm of the middle Motion of the Aphelion of* Mars *in the Tropical Year.* 2.26941.30			*Logarithm of the middle Motion of the northern Node of* Mars *in a Tropical Year.* 2.04297.83		

Middle Motion of Mars *from the* Æquinox *in the Tropical Years.*	
Trop. Years	*Decimal parts of a Circle.* 0.12345.678
1	53170.188
2	06340 376
3	59510 563
4	12680.751
5	65850.939
6	19021.127
7	72191.314
8	25361.502
9	78531.690

The Bounds of the Stations of Mars.				
The Anom. of the Eccentrick.	*The Angle of Commutation, or the Angle to the Sun.*			
	First.		*Second.*	
Sig.	Sig.	De. d. p. cir.	Sig.	De. d. p. cir.
00	05	7.67	05	8.22
02	05	10.37	05	11.22
03	05	14.00	05	14.38
04	05	17.28	05	17.28
06	05	20.33	05	19.82
08	05	15.13	05	15.13
09	05	12.77	05	12.45
10	05	6.93	05	9.90

TABLE XXXVI.

A Table of the Equation of the Centre of Mars.

	Subtract.						
Degrees.	*Sign* 0. De. dec. p.	Log. di.	*Sign* 1. De. dec. p.	Log. di.	*Sign* 2. De. dec. p.	Log. di.	*Degrees.*
0	00.0000	422131	04.8175	421714	08.6575	420499	30
1	00.1661	422131	04.9653	421685	08.7728	420447	29
2	00.3319	422130	05.1142	421654	08.8544	420392	28
3	00.4978	422128	05.2614	421625	08.9497	420339	27
4	00.6633	422123	05.4069	421593	09.0447	420284	26
5	00.8319	422121	05.5517	421564	09.1344	420230	25
6	00.9947	422115	05.6939	421529	09.2231	420172	24
7	01.1600	422110	05.8361	421498	09.3086	420115	23
8	01.3253	422102	05.9778	421463	09.3906	420058	22
9	01.4897	422094	06.1186	421426	09.4731	420028	21
10	01.6544	422084	06.2572	421392	09.5517	419940	20
11	01.8186	422076	06.3928	421354	09.6278	419882	19
12	01.9822	422066	06.5275	421317	09.7014	419821	18
13	02.1458	422053	06.6603	421277	09.7722	419761	17
14	02.3089	422040	06.7925	421240	09.8406	419700	16
15	02.4708	422027	06.9217	421200	09.9061	419637	15
16	02.6319	422011	07.0494	421157	09.9717	419576	14
17	02.7931	421995	07.1761	421115	10.0328	419512	13
18	02.9533	421979	07.3000	421072	10.0900	419449	12
19	03.1133	421964	07.4272	421029	10.1447	419388	11
20	03.2722	421945	07.5450	420984	10.1969	419324	10
21	03.4306	421924	07.6647	420938	10.2464	419257	9
22	03.6022	421906	07.7822	420892	10.2931	419190	8
23	03.7450	421885	07.8997	420847	10.3364	419125	7
24	03.9011	421864	08.0169	420798	10.3778	419058	6
25	04.0561	421840	08.1311	420752	10.4147	418993	5
26	04.2111	421817	08.2375	420701	10.4494	418927	4
27	04.3644	421790	08.3456	420653	10.4814	418859	3
28	04.5106	421767	08.4519	420602	10.5100	418789	2
29	04.6675	421740	08.5556	420550	10.5356	418721	1
30	04.8175	421714	08.6575	420499	10.5583	418653	0
	Sig. 11.		*Sign* 10.		*Sign* 9.		
	Add						

The Residue of Table XXVIII.

A Table of the Equation of the Centre of the Mars.

Subtract.

Degrees.	*Sign* 3. De. dec. p.	Log. di.	*Sign* 4. De. dec. p.	Log. di.	*Sign* 5. De. dec. p.	Log. di.	Degrees.
0	10.5583	418653	09.7106	416536	05.8881	414768	30
1	10.5756	418585	09.6300	416468	05.7156	414721	29
2	10.5947	418515	09.5458	416400	05.5408	414681	28
3	10.6075	418446	09.4586	416331	05.3639	414638	27
4	10.6178	418375	09.3675	416265	05.1853	414597	26
5	10.6242	418307	09.2739	416197	04.9972	414557	25
6	10.6281	418236	09.1783	416131	04.8211	414520	24
7	10.6281	418164	09.0731	416065	04.6361	414485	23
8	10.6264	418096	08.9683	415999	04.4489	414448	22
9	10.6244	418024	08.8617	415936	04.2606	414414	21
10	10.6111	417952	08.7511	415872	04.0794	414383	20
11	10.5947	417880	08.6367	415809	03.8769	414351	19
12	10.5781	417811	08.5181	415746	03.6828	414323	18
13	10.5600	417739	08.3989	415682	03.4872	414295	17
14	10.5381	417667	08.2753	415622	03.2900	414270	16
15	10.5125	417595	08.1456	415560	03.0917	414245	15
16	10.4833	417525	08.0153	415500	02.8908	414220	14
17	10.4517	417452	07.8822	415442	02.6906	414198	13
18	10.4158	417383	07.7458	415385	02.4886	414179	12
19	10.3761	417310	07.6069	415327	02.2856	414161	11
20	10.3333	417240	07.4647	415269	02.0811	414145	10
21	10.2867	417170	07.3200	415217	01.8756	414129	9
22	10.2367	417097	07.1722	415161	01.6689	414117	8
23	10.1906	417026	07.0219	415109	01.4614	414107	7
24	10.1269	416556	06.8717	415057	01.2536	414098	6
25	10.0667	416885	06.7119	415005	01.0458	414092	5
26	09.9994	416814	06.5528	414956	00.8375	414085	4
27	09.9319	416747	06.3917	414907	00.6283	414079	3
28	09.8617	416681	06.2278	414857	00.4189	414073	2
29	09.7881	416605	06.0600	414811	00.2097	414068	1
30	09.7106	416536	05.8881	414768	00.0000	414060	0
	Sign 8		*Sign* 7.		*Sign* 6.		

Add

TABLE XXXVII.

A Table of the Inclination of Mars, *and of his Reduction to the Ecliptick.*

Degrees.	Inclination,			Reduction, Subtract,			Degrees.
	Sign 0,	*Sign* 1,	*Sign* 2,	*Sign* 0,	*Sign* 1,	*Sign* 2,	
	Sign 6,	*Sign* 7,	*Sign* 8,	*Sign* 6,	*Sign* 7,	*Sign* 8,	
	De. p. d.	De. p. d.	De. p. d.	De. p. d.	De. p. d.	De. p. d.	
0	00.0000	00.9208	0 .5950	00.0000	00.0131	00.0131	03
1	00.0322	00.9483	01.6108	00.0003	00.0133	00.0128	29
2	00.0644	00.9756	01.6261	00.0008	00.0133	00.0125	28
3	00.0964	01.0025	01.6411	00.0014	00.0136	00.0122	27
4	00.1283	01.0292	01.6556	00.0019	00.0136	00.0119	26
5	00.1606	01.0558	01.6994	00.0025	00.0136	00.0117	25
6	00.1925	01.0819	01.6828	00.0031	00.0139	00.0114	24
7	00.2244	01.1078	01.6656	00.0036	00.0139	00.0108	23
8	00.2564	01.1333	01.7078	00.0042	00.0142	00.0106	22
9	00.2881	01.1586	01.7194	00.0044	00.0142	00.0103	21
10	00.3197	01.1836	01.7306	00.0050	00.0144	00.0100	20
11	00.3514	01.2083	01.7411	00.0056	00.0144	00.0094	19
12	00.3828	01.2325	01.7514	00.0061	00.0144	00.0092	18
13	00.4142	01.2564	01.7611	00.0067	00.0144	00.0089	17
14	00.4453	01.2797	01.7703	00.0072	00.0147	00.0083	16
15	00.4764	01.3028	01.7789	00.0078	00.0147	00.0078	15
16	00.5072	01.3253	01.7869	00.0083	00.0147	00.0072	14
17	00.5381	01.3472	01.7944	00.0089	00.0147	00.0067	13
18	00.5686	01.3689	01.8014	00.0092	00.0144	00.0061	12
19	00.5992	01.3903	01.8078	00.0094	00.0144	00.0056	11
20	00.6294	01.4111	01.8136	00.0100	00.0144	00.0050	10
21	00.6594	01.4317	01.8189	00.0103	00.014[illegible]	00.0044	9
22	00.6[illegible]94	01.4517	01.8[illegible]36	00.0106	00.0142	00.0042	8
23	00.7192	01.4711	01.8278	00.0108	00.0139	00.0036	7
24	00.7486	01.4903	01.8314	00.01[illegible]4	00.0139	00.0031	6
25	00.7778	01.5189	01.8344	00.0117	00.0136	00.0025	5
26	00.8069	01.5269	01.8369	00.0119	00.0136	00.0019	4
27	00.8358	01.5447	0 .8389	00.0122	00.0136	00.0014	3
28	00.8644	01.5619	01.8403	00.0125	00.0133	00.0008	2
29	00.8928	01.5786	01.8411	00.0128	00.0133	00.0003	1
30	00.9208	01.5950	01.8417	00.0131	00.0131	00.0000	0
	Sign 11,	*Sign* 10,	*Sign* 9,	*Sign* 11,	*Sign* 10,	*Sign* 9,	
	Sign 5.	*Sign* 4,	*Sign* 3,	*Sign* 5,	*Sign* 4,	*Sign* 3,	
				Add			

TABLE XXXVIII.

The Epochæ *of the middle Motions of* Venus, *in the Years of the Julian Period, for the Meridian of* Urenburgh, *in the Kalends of* January, *the Mid-day of Astronomical Time, according to the Julian Account.*

Middle Motion of Venus *from the* Æquinox.		*Middle Motion of the Aphelion of* Venus *from the* Æquinox.			*Middle Mot. of the northern Node of* Venus *from the* Æquinox.		
In a comp. Year of the Julian Period.	*Decimal parts of a Circle.*	*In a comp. Year of the Julian Period.*	*Signs.*	*Degrees, with decimal parts.*	*In a comp. Year of the Julian Period.*	*Signs.*	*Degrees, with decimal parts.*
0	9[illegible]9785	0	05	14.3789	0	11	20.5925
1000	488472	1000	06	6.0580	1000	00	3.6480
2000	027158	2000	06	27.7372	2000	00	16.7036
3000	565845	3000	07	19.4164	3000	00	29.7591
4000	104532	4000	08	11.0955	4000	01	12.8147
5000	643219	5000	09	2.7747	5000	01	25.8703
6000	181905	6000	09	24.4539	6000	02	8.9258
Logarithm of the mid. Mot. of Venus *in the Tropical Year.* 0.21098.80		*Logarithm of the middle Motion of the Aphelion of* Venus *in the Tropical Year.* $\bar{2}$.33603.34			*Logarithm of the middle Motion of the northern Node of* Venus *in a Tropical Year.* $\bar{2}$.11578.61		

Middle Motion of Venus *from the* Æquinox *in the Tropical Years.*	
Trop. Years	*Decimal parts of a Circle.* 0.12345.678
1	62550.457
2	25100.913
3	87651.370
4	50201.827
5	12752.283
6	75302.740
7	37853.196
8	00403.653
9	62954.110

The Bounds of the Stations of Mars.

The Anom. of the Eccentrick.	*The Angle of Commutation, or the Angle to the Sun.*			
	First.		*Second.*	
Sig.	Sig. De.	d. p. cir.	Sig. De.	d. p. cir.
00	05	17.78	05	17.97
03	05	17.97	05	17.58
06	05	16.92	05	16.72
09	05	16.72	05	17.12

TABLE XXXIX

A Table of the Equation of the Centre of Venus.

	Subtract						
Degrees.	*Sign* 0.		*Sign* 1.		*Sign* 2.		*Degrees.*
	De. dec. p.	Log. di.	De. dec. p.	Log. di.	De. dec. p.	Log. di.	
0	00.0000	386279	00.3931	386243	00.6828	386136	30
1	00.0133	386279	00.4047	386237	00.6897	386130	29
2	00.0267	386279	00.4164	386237	00.6961	386124	28
3	00.0400	386279	00.4278	386231	00.7028	386118	27
4	00.0542	386279	00.4392	386231	00.7092	386118	26
5	00.0678	386279	00.4503	386225	00.7153	386112	25
6	00.0814	386279	00.4617	386225	00.7211	386106	24
7	00.0950	386279	00.4725	386219	00.7264	386100	23
8	00.1083	386279	00.4836	386219	00.7322	386094	22
9	00.1219	386279	00.4944	386213	00.7372	386094	21
10	00.1353	386279	00.5053	386213	00.7425	386088	20
11	00.1486	386278	00.5164	386207	00.7478	386082	19
12	00.1622	386273	00.5264	386207	00.7517	386076	18
13	00.1758	386273	00.5369	386201	00.7561	386070	17
14	00.1892	386273	00.5469	386201	00.7606	386064	16
15	00.2025	386273	00.5567	386195	00.7644	386058	15
16	00.2158	386273	00.5664	386189	00.7678	386057	14
17	00.2292	386267	00.5761	386189	00.7711	386052	13
18	00.2419	386267	00.5856	386183	00.7742	386046	12
19	00.2553	386267	00.5947	386177	00.7769	386040	11
20	00.2681	386261	00.6039	386177	00.7792	386034	10
21	00.2808	386261	00.6128	386171	00.78 4	386028	9
22	00.2933	386261	00.6211	386165	00.7836	386027	8
23	00.3058	386255	00.6294	386165	00.7858	386022	7
24	00.3185	386255	00.6375	386159	00.7875	386016	6
25	00.3311	386255	00.6456	386153	00.7892	386010	5
26	00.3436	386249	00.6533	386153	00.7906	386004	4
27	00.3558	386249	00.6608	386147	00.7914	385998	3
28	00.3681	386249	00.6681	386141	00.7922	385997	2
29	00.3806	386249	00.6756	386136	00.7931	385992	1
30	00.3931	386243	00.68 8	386136	00.7931	385986	0
	Sign 11.		*Sign* 10.		*Sign* 9.		
	Add						

The Residue of Table XXXIX.

A Table of the Equation of the Centre of Venus.

Subtract

Degrees.	*Sign* 3. De. dec. p.	Log. di.	*Sign* 4. De. dec. p.	Log. di.	*Sign* 5. De. dec. p.	Log. di.	Degrees.
0	00.7931	385986	00.6897	385830	00.4000	385722	30
1	00.7933	385981	00.6831	385829	00.3878	385715	29
2	00.7933	385973	00.6761	385824	00.3756	385714	28
3	00.7931	385968	00.6686	385818	00.3633	385713	27
4	00.7925	385962	00.6611	385812	00.3508	385709	26
5	00.7914	385956	00.6533	385811	00.3383	385708	25
6	00.7900	385950	00.6453	385806	00.3256	385708	24
7	00.7883	385944	00.6375	385800	00.3125	385703	23
8	00.7867	385943	00.6292	385799	00.3000	385703	22
9	00.7850	385938	00.6208	385794	00.2869	385702	21
10	00.7828	385932	00.6125	385788	00.2739	385697	20
11	00.7803	385926	00.6036	385787	00.2606	385696	19
12	00.7778	385920	00.5944	385781	00.2472	385695	18
13	00.7750	385914	00.5847	385775	00.2336	385691	17
14	00.7719	385908	00.5753	385774	00.2203	385691	16
15	00.7686	385907	00.5656	385769	00.2067	385690	15
16	00.7650	385902	00.5556	385763	00.1931	385685	14
17	00.76[illegible]4	385896	00.5467	385762	00.1797	385684	13
18	00.7572	385890	00.5353	385757	00.1661	385684	12
19	00.7528	385884	00.5247	385754	00.1525	385684	11
20	00.7483	385878	00.5139	385751	00.1389	385683	10
21	00.7436	385872	00.5031	385745	00.1253	385682	9
22	00.7386	385871	00.4919	385743	00.1117	385682	8
23	00.7333	385866	00.4808	385739	00.0978	385679	7
24	00.7275	385860	00.4697	385737	00.0836	385679	6
25	00.7219	385854	00.4583	385735	00.0694	385679	5
26	00.7157	385848	00.4469	385733	00.0556	385679	4
27	00.7097	385842	00.4356	385731	00.0417	385679	3
28	00.7033	385842	00.4236	385727	00.0275	385679	2
29	00.6967	385836	00.4119	385724	00.0136	385679	1
30	00.6897	385830	00.4000	385722	00.0000	385679	0
	Sign 8		*Sign* 7.		*Sign* 6.		

Add

TABLE XL.

A Table of the Inclination of Venus, *and of her Reduction to the Ecliptick.*

Degrees.	Inclination, Sign 0, Sign 6, De.p.d.	Sign 1, Sign 7, De.p.d.	Sign 2, Sign 8, De.p.d.	Reduction, Subtract, Sign 0, Sign 6, De.p.d.	Sign 1, Sign 7, De.p.d.	Sign 2, Sign 8, De.p.d.	Degrees.
0	00.0000	01.6833	02.9156	00.0000	00.0431	00.0431	30
1	00.0589	01.7342	02.9447	00.0019	00.0439	00.0422	29
2	00.1178	01.7842	02.9731	00.0036	00.0450	00.0411	28
3	00.1764	01.3333	03.0003	00.0053	00.0458	00.0403	27
4	00.2353	01.8822	03.0264	00.0072	00.0464	00.0392	26
5	00.2936	01.9308	03.0514	00.0089	00.0472	00.0378	25
6	00.3519	01.9789	03.0756	00.0106	00.0478	00.0367	24
7	00.4100	02.0264	03.0987	00.0125	00.0483	00.0356	23
8	00.4681	02.0731	03.1214	00.0142	00.0486	00.0342	22
9	00.5261	02.1189	03.1431	00.0158	00.0489	00.0331	21
10	00.5842	02.1642	03.1636	00.0172	00.0489	00.0317	20
11	00.6419	02.2089	03.1831	00.0189	00.0492	00.0306	19
12	00.6969	02.2531	03.2017	00.0203	00.0494	00.0292	18
13	00.7575	02.2964	03.2194	00.0217	00.0494	00.0278	17
14	00.8147	02.3389	03.2361	00.0233	00.0497	00.0261	16
15	00.8714	02.3806	03.2519	00.0247	00.0497	00.0247	15
16	00.9278	02.4217	03.2667	00.0261	00.0497	00.0233	14
17	00.9839	02.4622	03.2778	00.0278	00.0494	00.0217	13
18	01.0400	02.5019	03.2933	00.0292	00.0494	00.0203	12
19	01.0958	02.5408	03.3050	00.0306	00.0492	00.0189	11
20	01.1514	02.5792	03.3158	00.0317	00.0489	00.0172	10
21	01.2067	02.6167	03.3256	00.0331	00.0489	00.0158	9
22	01.2617	02.6533	03.3342	00.0342	00.0486	00.0142	8
23	01.3158	02.6889	03.3419	00.0356	00.0483	00.0125	7
24	01.36[illegible]4	02.7236	03.3486	00.0367	00.0478	00.0106	6
25	01.4225	02.7578	03.3539	00.0378	00.0472	00.0089	5
26	01.4753	02.7911	03.3586	00.0392	00.0464	00.0072	4
27	01.5278	02.8233	03.3619	00.0403	00.0458	00.0053	3
28	01.5800	02.8550	03.3644	00.0411	00.0450	00.0036	2
29	01.6319	02.8856	03.3661	00.0422	00.0439	00.0019	1
30	01.6833	02.9156	03.3667	00.0431	00.0431	00.0000	0
	Sign 11, Sign 5,	Sign 10, Sign 4,	Sign 9, Sign 3,	Sign 11, Sign 5,	Sign 10, Sign 4,	Sign 9, Sign 3,	
				Add			

TABLE XLI.

The Epochæ *of the middle Motions of* Mercury, *in the Years of the Julian Period, for the Meridian of* Urenburgh, *in the Kalends of* January, *the Mid-day of Astronomical Time, according to the Julian Account.*

Middle Motion of Mercury *from the* Æquinox.		*Middle Motion of the Aphelion of* Mercury *from the* Æquinox.			*Middle Mot. of the northern Node of* Mercury *from the* Æquinox.		
In a comp. Year of the Julian Period.	*Decimal parts of a Circle.*	*In a comp. Year of the Julian Period.*	*Signs.*	*Degrees, with decimal parts.*	*In a comp. Year of the Julian Period.*	*Signs.*	*Degrees, with decimal parts.*
0	181505	0	02	9.0214	0	8	12.9378
1000	247954	1000	03	8.1372	1000	09	6.6167
2000	314403	2000	04	7.2530	2000	10	0.2956
3000	380852	3000	05	6.3689	3000	10	23.9745
4000	447301	4000	06	5.4847	4000	11	17.6534
5000	513750	5000	07	4.6005	5000	00	11.3322
6000	580199	6000	08	3.7164	6000	01	5.0111
Logarithm of the mid. Mot. of Mercury *in the Tropical Year.* 0.61825.50		*Logarithm of the middle Motion of the Aphelion of* Mercury *in the Tropical Year.* 2.46412.00			*Logarithm of the middle Motion of the northern Node of* Mercury *in a Trop. Year.* 2.37435.21		

Middle Motion of Merc. *from the* Æquinox *in the Tropical Years.*	
Trop. Years	*Decimal parts of a Circle.* 0·12345.678
1	15197.930
2	30395.859
3	45593.789
4	60791 719
5	75989.648
6	91187.578
7	06385.507
8	21583.437
9	36781.367

The Bounds of the Stations of Mercury.				
The Anom. of the Eccentrick.	*The Angle of Commutation, or the Angle to the Sun.*			
	First.		*Second.*	
Sig.	Sig.	De.d.p.cir.	Sig.	De.d.p.cir.
00	05	3.80	05	4 17
02	05	0.77	05	0.22
03	04	24.97	04	25.15
04	04	22.03	04	20.95
06	04	16.77	04	16.38
08	04	21.45	04	22.28
09	04	25.32	04	26.47
10	05	00.95	05	1.57

TABLE XLII.

A Table of the Equation of the Centre of Mercury.

	Subtract						
Degrees.	*Sign* 0. De. dec. p.	Log. di.	*Sign* 1. De. dec. p.	Log. di.	*Sign* 2. De. dec. p.	Log. di.	Degrees.
0	00.0000	367173	09.7475	366464	18.1139	364316	30
1	00.3322	367164	10.0572	366417	18.3500	364217	29
2	00.6644	367164	10.3644	366361	18.5825	364118	28
3	00.9967	367163	10.6697	366313	18.8125	364018	27
4	01.3286	367154	10.9739	366257	19.0383	363919	26
5	01.6608	367145	11.2772	366200	19.2603	363809	25
6	01.9919	367136	11.5786	366143	19.4792	363709	24
7	02.3228	367128	11.8781	366087	19.6942	363599	23
8	02.6536	367117	12.1756	366030	19.9053	363498	22
9	02.9842	367108	12.4706	365973	20.1125	363387	21
10	03.3144	367089	12.7642	365906	20.3156	363276	20
11	03.6439	367070	13.0556	365839	20.5144	363165	19
12	03.9731	367052	13.3444	365782	20.7094	363043	18
13	04.3014	367034	13.6311	365706	20.8994	362931	17
14	04.6292	367015	13.9161	365639	21.0858	362808	16
15	04.9561	366987	14.1983	365571	21.2683	362696	15
16	05.2825	366969	14.4781	365495	21.4456	362572	14
17	05.6081	366941	14.7556	365418	21.6178	362449	13
18	05.9331	366922	15.0311	365350	21.7858	362324	12
19	06.2567	366885	15.3036	365273	21.9483	362201	11
20	06.5797	366857	15.5733	365186	22.1069	362076	10
21	06.9019	366820	15.8408	365108	22.2603	361941	9
22	07.2228	366792	16.1058	365031	22.4086	361815	8
23	07.5425	366755	16.3658	364943	22.5511	361679	7
24	07.8614	366717	16.6256	364856	22.6894	361542	6
25	08.1789	366380	16.8817	364777	22.8219	361405	5
26	08.4956	366633	17.1347	364689	22.9458	361267	4
27	08.8106	366596	17.3839	364591	23.0683	361140	3
28	09.1242	366549	17.6306	364503	23.1842	361991	2
29	09.4304	366502	17.8739	364404	23.2936	361853	1
30	09.7475	366464	18.1139	364316	23.3981	360713	0
	Sign 11		*Sign* 10.		*Sign* 9.		
	Add						

The Residue of Table XLII.

A Table of the Equation of the Centre of Jupiter.

Subtract

Degrees.	*Sign* 3. De. dec. p.	Log. di.	*Sign* 4. De. dec. p.	Log. di.	*Sign* 5. De. dec. p.	Log. di.	Degrees.
0	23.3981	360713	23.2986	355883	15.3294	350947	30
1	23.4958	360573	23.1711	355642	14.9017	350812	29
2	23.5878	360423	23.0344	355534	14.4931	350678	28
3	23.6739	360271	22.8883	355352	14.0617	350556	27
4	23.7533	360130	22.7339	355182	13.5892	350420	26
5	23.8267	359977	22.5697	354998	13.1739	350297	25
6	23.8994	359824	22.3967	354851	12.7167	350174	24
7	23.9542	359671	22.2131	354667	12.2514	350051	23
8	24.0078	359517	22.0203	354494	11.7786	349941	22
9	24.0547	359362	21.8178	354320	11.2989	349831	21
10	24.0947	359207	21.6069	354145	10.8117	349734	20
11	24.1278	359051	21.3850	353970	10.3175	349624	19
12	24.1539	358894	21.1539	353794	09.8161	349527	18
13	24.1725	358737	20.9125	353631	09.3086	349443	17
14	24.1839	358580	20.6617	353453	08.7958	349346	16
15	24.1881	358410	20.4008	353288	08.2758	349262	15
16	24.1847	358252	20.1308	353122	07.7497	349192	14
17	24.1742	358092	19.8506	352956	07.2194	349122	13
18	24.1558	357921	19.5614	352789	06.6836	349052	12
19	24.1294	357749	19.2614	3526[illegible]1	06.1433	348982	11
20	24.0953	357588	18.9525	352466	05.5983	348925	10
21	24.0536	357426	18.6336	352310	05.0500	348883	9
22	24.0036	357252	18.3047	352140	04.4981	348827	8
23	23.9453	357078	17.9656	351983	03.9422	348786	7
24	23.8789	356914	17.6178	351825	03.3842	348756	6
25	23.8039	356738	17.2597	351680	02.8233	348728	5
26	23.7203	356573	16.8922	351534	02.2611	348700	4
27	23.6278	356396	16.5164	351375	01.6975	348671	3
28	23.5269	356229	16.1297	351228	01.1325	348657	2
29	23.4172	356050	15.7339	351095	00.6481	348657	1
30	23.2986	355883	15.3294	350947	00.0000	348650	0
	Sign 8.		*Sign* 7.		*Sign* 6.		

Add

TABLE XLIII.

A Table of the Inclination of Mercury, *and of his Reduction to the Ecliptick.*

Degrees.	Inclination,				Reduction, Subtract,			Degrees.
	Sign 0,	*Sign* 1,	*Sign* 2,		*Sign* 0,	*Sign* 1,	*Sign* 2,	
	Sign 6,	*Sign* 7,	*Sign* 8,		*Sign* 6,	*Sign* 7,	*Sign* 8,	
	De. p. d.	De. p. d.	De. p. d.		De. p. d.	De. p. d.	De. p. d.	
0	00.0000	03.4500	05.9756		00.0000	00.1803	00.1803	30
1	00.1203	03.5536	06.0350		00.0072	00.1839	00.1767	29
2	00.2408	03.6561	06.0925		00.0144	00.1872	00.1728	28
3	00.3611	03.7578	06.1481		00.0217	00.1903	00.1686	27
4	00.4814	03.8583	06.2017		00.0289	00.1931	00.1642	26
5	00.6014	03.0578	06.2536		00.0361	00.1956	00.1594	25
6	00.7211	04.0558	06.3036		00.0431	00.1981	00.1547	24
7	00.8406	04.1525	06.3517		00.0503	00.2003	00.1497	23
8	00.9600	04.2481	06.3975		00.0572	00.2022	00.1447	22
9	01.0792	04.3422	06.4414		00.0642	00.2039	00.1394	21
10	01.1981	04.4350	06.4833		00.0711	00.2053	00.1339	20
11	01.3164	04.5264	06.5233		00.0778	00.2064	00.1283	19
12	01.4344	04.6167	06.5617		00.0844	00.2072	00.1225	18
13	01.5519	04.7056	06.5981		00.0911	00.2078	00.1164	17
14	01.6689	04.7931	06.6325		00.0975	00.2081	00.1103	16
15	01.7856	04.8792	06.6647		00.1039	00.2083	00.1039	15
16	01.9017	04.9636	06.6950		00.1103	00.2081	00.0975	14
17	02.0172	05.0467	06.7231		00.1164	00.2078	00.0911	13
18	02.1322	05.1281	06.7492		00.1225	00.2072	00.0844	12
19	02.2464	05.2078	06.7733		00.1283	00.2064	00.0778	11
20	02.3597	05.2858	06.7653		00.1339	00.2053	00.0711	10
21	02.4725	05.3622	06.8150		00.1394	00.2039	00.0642	9
22	02.5847	05.4369	06.8328		00.1447	00.2022	00.0572	8
23	02.6961	05.5103	06.8486		00.1497	00.2003	00.0503	7
24	02.8067	05.5819	06.8650		00.1547	00.1981	00.0431	6
25	02.9161	05.6519	06.8736		00.1594	00.1956	00.0361	5
26	03.0247	05.7203	06.8831		00.1642	00.1931	00.0289	4
27	03.1325	05.7869	06.8906		00.1686	00.1903	00.0217	3
28	03.2394	05.8517	06.8958		00.1728	00.1872	00.0144	2
29	03.3453	05.9144	06.8989		00.1767	00.1839	00.0072	1
30	03.4500	05.9756	06.9000		00.1803	00.1803	00.0000	0
	Sign 11,	*Sign* 10,	*Sign* 9,		*Sign* 11,	*Sign* 10,	*Sign* 9,	
	Sign 5,	*Sign* 4,	*Sign* 3,		*Sign* 5,	*Sign* 4,	*Sign* 3,	
				Add				

TABLE XLIV.

A Catalogue of the most noted fixed Stars.

The Names of the Stars.	*Signs.*	*Longitude.* D.p.d.	*Latitude.* D.p.d.		*Signs.*
The Southern Star in the Fore-horn of *Aries*, called the first.	00	0.000	7.142	*B*	4
The left Foot of *Andromeda.*	00	11.033	27.775	*B*	2
The bright Star of the Jaw of the Whale.	00	11.167	12.617	*A*	2
The Head of *Medusa.*	00	23.000	22.367	*B*	3
The bright Star of *Pleiades.*	00	26.783	4.000	*B*	3
The right Side of *Perseus.*	00	28.667	30.083	*B*	2
The Southern Eye of *Taurus, Aldebara.*	01	6.592	5.517	*A*	1
The left Foot of *Orion, Regel.*	01	13.667	31.183	*A*	1
The left Shoulder of *Orion.*	01	17.767	16.883	*A*	2
The Kid, or Hee-goat.	01	18.650	22.842	*B*	1
The first in the Girdle of *Orion.*	01	19.225	23.633	*A*	2
The right Ankle of *Auriga.*	01	19.375	5.333	*B*	2
The middlemost in the Girdle of *Orion.*	01	20.283	24.555	*A*	2
The last in the Girdle of *Orion.*	01	21.492	25.355	*A*	2
The last in the Tail of the lesser Bear, called the Pole Star.	01	25.425	66.033	*B*	2
The right Shoulder of *Orion.*	01	25.583	16.100	*A*	2
The bright Star in the right Shoulder of *Auriga.*	01	28. 50	21 455	*B*	2
In the bottom of the fore Foot of the Dog.	02	4.092	41.305	*A*	2
The bright Star of the left Foot of *Gemini.*	02	5.900	6.805	*A*	2
The greater Dog, *Sirius.*	02	10.975	39.500	*A*	1
The Northern Head of *Gemini, Castor.*	02	17.067	10.033	*B*	2
The Southern Head of *Gemini, Pollux.*	02	20.100	6.633	*B*	2
The lesser Dog, *Procyon.*	02	22.692	15.950	*A*	2
Præsepe, the Breast of *Cancer.*	03	4.155	1.233	*B*	ne.
The Northern Ass.	03	4.333	3.133	*B*	4
The Southern Ass.	03	5.517	0.067	*B*	4
The Northern Fore-Star of *Charles*'s Wane.	03	11 950	49.667	*B*	2
The Southern Fore-Star of *Charles*'s Wane.	03	16.105	45.055	*B*	2
The Heart of *Hydra.*	03	24.142	22.400	*A*	1
The Neck of *Leo.*	03	26.367	8 783	*B*	2
The Heart of *Regulus.*	03	26.667	0.442	*B*	1
The Southern hinder Star of *Charles*'s Wane.	03	27.133	47.105	*B*	2
The Northern hinder Star of *Charles*'s Wane.	03	27.805	51.617	*B*	2
The third from the last in the Tail of the Dragon.	04	4.555	66.600	*B*	2
The Root of the Tail of the greater Bear.	04	5.550	54.300	*B*	2
The Back of *Leo.*	04	8.067	14 333	*B*	2

The Residue of Table XLIV.

A Catalogue of the most noted fixed Stars.

The Names of the Stars.	*Signs.*	*Longitude.* D. p.d.	*Latitude.* De. p. d.	
The last save one in the Tail of the greater Bear.	04	12.325	56.367 *B*	2
The Tail of *Leo*.	04	18.433	12.300 *B*	1
The irregular Star in *Charles's* Wain about the Tail.	04	20.105	40.100 *B*	2
The last in the Tail of the greater Bear.	04	23.583	54 417 *B*	2
The Wing of the Virgin *Vindemiatrix*.	05	6.767	16.255 *B*	3
Spica Virginis.	05	20.650	1.983 *A*	1
The Star by the Tail of the greater Bear, *Arcturus*.	05	21.033	31.042 *B*	1
The bright Star in the *Gnostan* Crown.	06	9.025	44 383 *B*	2
The Southern Scale of *Libra*.	06	11.900	0.433 *B*	2
The Northern Scale of *Libra*.	06	16. 83	8.583 *B*	2
The bright Star in the neck of the Serpent.	06	18.883	25.583 *B*	2
The left hand of *Ophiuchus*.	06	29.125	17.317 *B*	3
The uppermost Star in the Forehead of *Scorpio*.	06	29.983	1 083 *B*	2
The Heart of *Scorpio*, *Antares*.	07	6 600	4.450 *A*	1
The Head of *Hercules*.	07	12.900	37.383 *B*	3
The Head of *Ophiuchus*.	07	19.217	35.950 *B*	3
The bright Star of *Lyra*.	08	12.100	61.792 *B*	1
The Bill of the Swan.	08	28.117	49.033 *B*	3
The more Northern of the three in the Horn of *Capricorn*.	09	0.683	7.033 *B*	3
The more Southern of the three in the Horn of *Capricorn*.	09	0.900	4.683 *B*	3
The foremost of the two bright Stars in the Tail of *Capricorn*.	09	18.617	2.433 *A*	3
The left Shoulder of *Aquarius*.	09	20.233	8.700 *B*	3
The hinder part of the Tail of *Capricorn*.	09	20.383	2 483 *A*	3
The Breast of the Swan.	09	21.800	57.150 *B*	3
The Mouth of *Pegasus*.	09	28.750	22 125 *B*	3
The right Shoulder of *Aquarius*.	10	0.200	10.700 *B*	3
Fomahant.	10	0.575	21.000 *A*	1
The Tail of the Swan.	10	2 275	59.942 *B*	2
Marchab Pegasus.	10	20 325	19.433 *B*	2
Scheat Pegasus.	10	26.200	31.125 *B*	2
The Tail of the Whale.	10	29.317	20.783 *A*	2
The last in the Wing of *Pegasus*.	11	6.013	12.583 *B*	2
The Head of *Andromeda*.	11	11.167	25.700 *B*	2
The knot of the Fish-net.	11	26.175	9 075 *A*	3
The Girdle of *Andromeda*.	11	27.200	25.983 *B*	2

TABLE XLV.

A Table of Declinations, and of the Angles of the Ecliptick and Meridian.

Degrees.	Declinations. ♈ ♎ De. p. d.	Declinations. ♉ ♏ De. p. d.	Declinations. ♊ ♐ De. p. d.	Angles of the Ecliptick and Meridian. ♈ ♎ De. p. d.	Angles of the Ecliptick and Meridian. ♉ ♏ De. p. d.	Angles of the Ecliptick and Meridian. ♊ ♐ De. p. d.	Degrees.
0	00.0000	11.5003	20.2017	66.50	69.37	77.73	30
1	00.3986	11.8511	20.4111	66.50	69.57	78.10	29
2	00.7975	12.1989	20.6142	66.52	69.77	78.47	28
3	01.1958	12.5431	20.8111	66.53	69.97	78.83	27
4	01.5939	12.8839	21.0017	66.55	70.18	79.20	26
5	01.9917	13.2214	21.1856	66.58	70.40	79.58	25
6	02.3889	13.5550	21.3631	66.62	70.62	79.97	24
7	02.7853	13.8850	21.5339	66.65	70.85	80.35	23
8	03.1814	14.2111	21.6981	66.70	71.08	80.75	22
9	03.5761	14.5333	21.8553	66.77	71.33	81.15	21
10	03.9706	14.8514	22.0058	66.82	71.58	81.55	20
11	04.3636	15.1653	22.1494	66.88	71.83	81.95	19
12	04.7556	15.4747	22.2861	66.97	72.10	82.35	18
13	05.1464	15.7800	22.4158	67.03	72.37	82.75	17
14	05.5358	16.0808	22.5383	67.12	72.63	83.17	16
15	05.9236	16.3772	22.6539	67.22	72.92	83.58	15
16	06.3103	16.6686	22.7619	67.32	73.20	84.00	14
17	06.6950	16.9553	22.8631	67.42	73.48	84.42	13
18	07.0781	17.2372	22.9567	67.53	73.78	84.83	12
19	07.4592	17.5142	23.0431	67.65	74.08	85.25	11
20	07.8383	17.7858	23.1219	67.78	74.38	85.68	10
21	08.2156	18.0525	23.1936	67.90	74.70	86.12	9
22	08.5906	18.3136	23.2578	68.05	75.02	86.53	8
23	08.9633	18.5694	23.3144	68.18	75.33	86.97	7
24	09.3339	18.8200	23.3636	68.33	75.67	87.40	6
25	09.7017	19.0647	23.4053	68.50	76.00	87.83	5
26	10.0669	19.3039	23.4394	68.65	76.33	88.27	4
27	10.4297	19.5372	23.4658	68.82	76.68	88.70	3
28	10.7894	19.7647	23.4847	69.00	77.02	89.13	2
29	11.1464	19.9864	23.4961	69.18	77.38	89.57	1
30	11.5003	20.2017	23.5000	69.37	77.73	90.00	0
	♓ ♍	♒ ♌	♑ ♋	♍ ♓	♒ ♌	♑ ♋	

TABLE XLVI.

A Table of Right Ascensions.

Degrees.	*Sign* ♈	♉	♊	♋	♌	♍
	De. dec. p.	*De. dec. p.*	*De. dec. p.*	*De. dec. p.*	*De. dec. p.*	*De. dec. p.*
0	000.0000	027.8997	057.8069	090.0000	122.1931	152.1203
1	000.9169	028.8558	058.8494	091.0906	123.2331	153.0542
2	001.8352	029.8144	059.8950	092.1808	124.2700	154.0058
3	002.7517	030.7758	060.9419	093.2708	125.3039	154.9550
4	003.6692	031.7394	061.9939	094.3606	126.3350	155.9019
5	004.5872	032.7058	063.0475	095.4497	127.3631	156.8469
6	005.5056	033.6747	064.1036	096.5381	128.3881	157.7897
7	006.4244	034.6467	065.1622	097.6258	129.4103	158.7306
8	007.3442	035.6211	066.2233	098.7128	130.4292	159.6694
9	008.2644	036.5983	067.2867	099.7989	131.4453	160.6067
10	009.1853	037.5783	068.3525	100.8836	132.4581	161.5419
11	010.1072	038.5614	069.4203	101.9672	133.4681	162.4756
12	011.0303	039.5472	070.4906	103.0497	134.4750	163.4075
13	011.9542	040.5361	071.5625	104.1306	135.4789	164.3381
14	012.8792	041.5281	072.6367	105.2097	136.4794	165.2669
15	013.8056	042.5228	073.7125	106.2875	137.4772	166.1944
16	014.7331	043.5206	074.7903	107.3633	138.4719	167.1208
17	015.6619	044.5211	075.8694	108.4375	139.4639	168.0458
18	016.5925	045.5250	076.9503	109.5094	140.4528	168.9697
19	017.5244	046.5319	078.0328	110.5797	141.4386	169.8928
20	018.4553	047.5419	079.1164	111.6475	142.4217	170.8147
21	019.3933	048.5547	080.2011	112.7133	143.4017	171.7356
22	020.3306	049.5708	081.2872	113.7767	144.3789	172.6558
23	021.2694	050.5897	082.3742	114.8378	145.3533	173.5756
24	022.2103	051.6119	083.4619	115.8992	146.3253	174.4944
25	023.1531	052.6369	084.5503	116.9525	147.2942	175.4128
26	024.0981	053.6650	085.6394	118.0061	148.2606	176.3308
27	025.0450	054.6961	086.7292	119.0569	149.2242	177.2483
28	025.9942	055.7300	087.8192	120.1050	140.1856	178.1658
29	026.9458	056.7669	088.9094	121.1506	151.1442	179.0831
30	027.8997	057.8069	090.0000	122.1931	152.1003	180.0000

The Residue of Table XLVI.

A Table of the Right Ascension.

Degrees.	Sign ♎	♏	♐	♑	♒	♓
	De. dec. p.	De. dec. p.	De. dec. p.	De. dec. p.	De. dec. p.	De. dec. p.
0	180.0000	207.8997	237.8069	270.0000	302.1931	332.1003
1	180.9169	208.8558	238.8494	271.0906	303.2331	333.0542
2	181.8342	209.8144	239.8950	272.1808	304.2700	334.0058
3	182.7517	210.7758	240.9419	273.2708	305.3039	334.9550
4	183.6692	211.7399	241.9939	274.3606	306.3350	335.9019
5	184.5872	212.7058	243.0475	275.4497	307.3631	336.8469
6	185.5056	213.6747	244.1036	276.5381	308.3881	337.7897
7	186.4244	214.6467	245.1622	277.6258	309.4103	338.7306
8	187.3442	215.6211	246.2233	278.7128	310.4292	339.6694
9	188.2644	216.5983	247.2867	279.7989	311.4453	340.6067
10	189.1853	217.5773	248.3525	280.8836	312.4581	341.5419
11	190.1072	218.5614	249.4203	281.9672	313.4681	342.4756
12	191.0303	219.5472	250.4906	283.0497	314.4750	343.4075
13	191.9542	220.5361	251.5625	284.1306	315.4789	345.3381
14	192.8792	221.5281	252.6267	285.2097	316.4794	345.2669
15	193.8056	222.5228	253.7125	286.2875	317.4772	346.1944
16	194.7331	223.5206	254.7903	287.3633	318.4719	347.1208
17	195.6619	224.5211	255.8694	288.4375	319.4639	348.0458
18	196.5925	225.5250	256.9503	289.5094	320.4528	348.9697
19	197.5244	226.5319	258.0328	290.5797	321.4386	349.8928
20	198.4553	227.5419	259.1164	291.6475	322.4217	350.8147
21	199.3933	228.5547	260.2011	292.7133	323.4017	351.7356
22	200.3306	229.5708	261.2872	293.7767	324.3789	352.6558
23	201.2694	230.5897	262.3742	294.8378	325.3533	353.5756
24	202.2103	231.6119	263.4619	295.8992	326.3253	354.4944
25	203.1531	232.6369	264.5503	296.9525	327.2942	355.4128
26	204.0981	233.6650	265.6394	298.0061	328.2606	356.3308
27	205.0450	234.6961	266.7292	299.0569	329.2242	357.2483
28	205.9942	235.7300	267.8192	300.1050	330.1856	358.1658
29	206.9458	236.7669	268.9094	301.1506	331.1442	359.0831
30	207.8997	237.8069	270.0000	302.1931	332.1003	360.0000

AN APPENDIX.

CONTAINING

Divers neceſſary Rules and Tables

Relating to

I. Gauging of Brewers Tuns and Coppers, and of Wine or Ale Veſſels.

II. Meaſuring of Timber Growing, and of the Works of the ſeveral Artificers belonging to the Building of Houſes or other Edifices.

Proœme.

I Intend not here to treat of the whole Art of Practical *Gauging*; neither of the Meaſuring of Timber growing or Un-hewn; nor of the Works of the ſeveral *Artificers* belonging to *Building*: As the *Bricklayers*, *Carpenters*, *Maſons*, *Plaiſterers*, *Joyners*, *Painters*, *Glaſiers*, *Paviers*, &c. For he that can meaſure Superficies and Solids, both Regular and Irregular, (the performance whereof is taught at large in the Second Book of Geometry, in the Third Part thereof, from Page 301 to Page 330, and that both *Arithmetical* and *Inſtrumentally*) cannot be ignorant of the performance of any of theſe things. And therefore, I ſhall here only give a ſhort Account of ſuch *Cuſtoms* as are uſed in the *Menſurations* of theſe *Particular Works*; and exhibit to view ſome Tables ready Calculated which may be of good uſe to ſuch Gentlemen and others who may have occaſion to make uſe of them.

SECT.

SECTION I.

Of the Gauging of Wine or Ale Vessels, and to find the content of them in Wine or Ale Gallons, and parts of Gallons: Also of Brewers Tuns and Coppers, and to find their Contents in Barrels, and parts of Barrels.

A Table for the exact and ready Gageing of any close Cask or Vessel, and to give the content thereof in Wine Gallons, and 1000 parts of a Gallon.

The Number of whole Inches in the Diameter of any Cask.

	Quarters of Inches.			
	0 Quar.	1 Quar.	2 Quar.	3 Quar.
10	0.1133	0.1190	0.1250	0.1330
11	0.1371	0.1434	0,1499	0.1565
12	0 1632	0.1701	0.1771	0.1842
13	0.1915	0.1990	0.2066	0.2143
14	0.2221	0.2300	0.2383	0.2466
15	0.2550	0.2636	0.2723	0.2811
16	0.2991	0.2993	0.3086	0.3180
17	0.3275	0.3372	0.3471	0.3570
18	0.3672	0.3775	0.3879	0.3984
19	0.4091	0.4200	0.4319	0.4420
20	0.4533	0.4647	0.4763	0.4880
21	0.4998	0.5117	0.5272	0.5362
22	0.5485	0.5609	0.5734	0.5866
23	0.5995	0.6126	0.6259	0.6393
24	0.6528	0.6665	0.6803	0.6943
25	0.7083	0.7226	0.7370	0.7515
26	0.7661	0.7808	0.7969	0.8110
27	0.8262	0.8416	0.8571	0.8727
28	0.8885	0.9044	0.9206	0.9368
29	0.9531	0.9696	0.9863	1.0031
30	1.0200	1.0370	1.0543	1.0716
31	1.0891	1.1064	1.1245	1.1425
32	1.1605	1.1787	1.1971	1.2156
33	1.2342	1.2530	1.2719	1.2910
34	1.3101	1.3298	1.3490	1.3686
	1.3833			
35	1.4688	1.4083	1.4283	1.4485
36	1.5513	1.4893	1.5099	1.5306
37	1.6365	1.5726	1.5938	1.6184
38	1.7238	1.6581	1.6799	1.7018
39	1.8133	1.7460	1.7683	1.7908
40	1.9051	1.8361	1.8589	1.8819
41	1.9992	1.9285	1.9519	1.9755
42	2.0955	2.0231	2.0471	2.0713
43	2.1941	2.1199	2.1445	2.1693
44	2.2950	2.2291	2.2443	2.2696
45	2.3981	2.3206	2.3463	2.3722
46	2.5035	2.4243	2.4506	2.4770
47	2.6112	2.5303	2.5571	2.5840
48	2.7211	2.6385	2.6659	2.6934
49	2.8333	2.7489	2.7736	2.8051
50	2.9478	2.8617	2.8867	2.9190
51	3.0545	2.9768	3.0059	3.0352
52	3.1835	3.0941	3.1237	3.1536
53	3.3048	3.2136	3.2439	3.2743
54	3.4283	3.3355	3.3663	3.3972
55	3.5541	3.4596	3 4910	3.5224
56	3.5822	3.5859	3.6179	3.6500
57	3.8125	3.7146	3.7471	3.7797
58	3.9451	3.8454	3.8786	3.9118
59	4.0800	9786	4.0123	4.0461
60		4.1141	4.1483	4.1826

A Table for the exact and ready Gageing of any close Cask or Vessel, and to give the Content thereof in Ale Gallons, and 1000 parts of a Gall.

The Number of whole Inches in the Diameter of any Cask or Vessel.

	Quarters of Inches.			
	0 Qua.	1 Qua.	2 Qua.	3 Qua.
10	0.092	0.098	0.102	0.107
11	0.112	0.117	0.123	0.128
12	0.134	0.139	0.145	0.151
13	0.157	0.163	0.169	0.176
14	0.182	0.188	0.193	0.202
15	0.209	0.216	0.223	0.230
16	0.238	0.243	0.253	0.260
17	0.267	0.274	0.284	0.292
18	0.301	0.308	0.318	0.326
19	0.335	0.342	0.353	0.362
20	0.371	0.381	0.357	0.399
21	0.409	0.419	0.429	0.439
22	0.449	0.459	0.470	0.480
23	0.491	0.501	0.512	0.524
24	0.534	0.546	0.557	0.568
25	0.580	0.592	0.604	0.616
26	0.628	0.639	0.652	0.664
27	0.677	0.689	0.702	0.725
28	0.728	0.741	0.754	0.767
29	0.781	0.794	0.808	0.822
30	0.836	0.849	0.864	0.878
31	0.892	0.907	0.921	0.935
32	0.951	0.963	0.980	0.996
33	1.011	1.026	1.042	1.057
34	1.073	1.089	1.105	1.121
35	1.137	1.153	1.170	1.187
36	1.203	1.220	1.233	1.254
37	1.271	1.288	1.305	1.323
38	1.341	1.358	1.376	1.394
39	1.712	1.430	1.445	1.467
40	1.485	1.504	1.523	1.541
41	1.561	1.579	1.599	1.618
42	1.638	1.657	1.697	1.697
43	1.717	1.737	1.757	1.777
44	1.797	1.817	1.838	1.859
45	1.880	1.901	1.922	1.943
46	1.964	1.986	2.007	2.029
47	2.051	2.072	2.095	2.117
48	2.139	2.161	2.183	2.206
49	2.229	2.252	2.274	2.298
50	2.321	2.344	2.367	2.391
51	2.414	2.438	2.462	2.486
52	2.510	2.534	2.553	2.583
53	2.601	2.631	2.657	2.682
54	2.707	2.732	2.757	2.782
55	2.908	2.834	2.856	2.885
56	2.911	2.934	2.964	2.990
57	3.016	3.043	3.069	3.096
58	3.123	3.150	3.177	3.204
59	3.232	3.292	3.287	3.314
60	3.342	3.373	3.398	3.426

The Use of the Tables *for the* Gauging *of* Wine *or* Ale *Vessels.*

To Gauge any *Wine* or *Ale Cask* or *Vessel*, you must first take the *Diametres* at the *Head* and *Bung* of the *Vessel*, and also the *length* of the Vessel within; in Inches, and quarters of Inches, which being truly taken, the *Content* of the *Cask* in *Wine* or *Ale Gallons*, and parts of a *Gallon*, may exactly be found by these Tables.

Example 1. *Let there be a Wine Vessel, whose Diametre at the Bung is* 32 *Inches, at the Head* 17 *Inches, and the length thereof* 54 *Inches; and let the Content thereof be required in Wine Gallons, and parts of a Gallon.*

Look into the Table, and find 32 Inches (the Diametre at the Bung) in the first Column, against which stands 1.1605, which number you must set down twice. Also look in the first Column for 17 the Diametre at the Head, against which stands 0.3275, which number set down under the two former, and add all three together, and their Summ will be 2.6485, which Summ you must multiply by 54, the length of the Vessel, and the Product will be 143.0190, from which cut off four Figures to the right hand, and there will remain 143 Gallons and .019 thousand parts of a Gallon, which is not a quarter of a Pint. For

$$\left.\begin{array}{l}.125\\.250\\.375\\.500\\.625\\.750\\.875\end{array}\right\}\text{Parts cut off are equal to}\left\{\begin{array}{c}1\\2\\3\\4\\5\\6\\7\end{array}\right\}\text{Pints.}$$

See the following Work.

Diametre at the Bung 32 Inches	1.1605
The same again	1.1605
Diametre at the Head 17 Inches	0.3275
	26485
The length of the Cask 54 Inches	54
	105940
	132425
The Content of the Vessel	143.0190

143 Gallons, and .019 parts of a Gallon, which is not a quarter of a Pint.

Example 2. *Let there be a Wine Cask, whose Diametre at the Bung is* 29 *Inches and a half, at the Head* 23 *Inches and a quarter, and the length* 47 *Inches and a half, to find the Content in Wine Gallons.*

Look for 29 Inches in the first Column of the Table, and for 2 quarters (which is half an Inch) at the head of the Table, and against 29 and under 2 quarters, you shall find this number, 0.9863, which set down twice; Also look for 23 Inches in the first Column, and 1 quarter at the head of the Table; and against 23, and under 1 quarter you shall find this Number, 0.6126, which set under other two, and these three numbers added together, make 2.5852, which number multiplyed by 47 Inches and a half, (that is, by 47 5, for 25.8 for a quarter of an Inch, 5 for half, and 75 for 3 quarters of an Inch) the Product will be 122.79700, from which cut off the five last Figures to the right hand, and there will be 122 Gallons, and 797 thousand parts of a Gallon, which is somewhat above six Pints.

Diametre

Diametre at the Bung 29 ½ Inches	0.9863
The same again	0.9863
Diametre at the Head 23 ¼ Inches	06126
The Summ	25852
The length of the Vessel 47 ½ Inches	47.5
	129260
	180964
	103408
	122.79700

The reason why five Figures were now cut off is, because of the parts of an Inch in the length of the Cask, for had the length been only 47 Inches, you should then have cut off only 4 Figures as before; and had the length been 47 ¾ or 47 ¼ which are thus to be expressed 47.25, and 47.75, you must then have cut off 6 Figures, &c.

The Table for the Gauging of Beer or Ale Vessels, is to be used in all respects as that for the Gauging of Wine Cask. And therefore one *Example* shall serve to shew the Use of it. Which let be this following.

Example. *There is a Vessel, whose Diametre at the Bung is 34 Inches and a half, at the Bung 26 Inches and a quarter, and is long 54 Inches, How many Ale Gallons are contained therein?*

The Diametre at the Bung 34½	1.105
The same again	1.105
The Diametre at the Head 26 ¼	0.639
The Summ	2.849
The length of the Vessel	54
	11396
	14245
The Content	153 | 846

That is 153 Gallons, and almost 7 Pints.

A Table shewing the Content of any Round Brewers Tun in Barrels, and 10000 Parts of a Barrel.

The Diametre of the Tun in Inches.	B.Parts	The Diametre &c.	B.Parts	The Diametre &c.	B.Parts
1	0.0001	41	0.1300	81	0.5077
2	.0003	42	.1364	82	.5203
3	.0007	43	.1430	83	.5331
4	.0010	44	.1498	84	.5466
5	.0019	45	.1568	85	.5591
6	0.9023	46	0.1639	86	0.5723
7	.0038	47	.1711	87	.5857
8	.0050	48	.1784	88	.5992
9	.0063	49	.1858	89	.6129
10	.0077	50	.1934	90	.6268
11	0.0094	51	0.2012	91	0.6408
12	.0112	52	.2092	92	.6549
13	.0131	53	.2173	93	.6692
14	.0152	54	.2256	94	.6836
15	.0174	55	.2340	95	.6982
16	0.0198	56	0.2426	96	.7130
17	.0223	57	.2514	97	.7279
18	.0256	58	.2603	98	.7430
19	.0279	59	.2693	99	.7584
20	.0308	60	.2785	100	.7737
21	0.0341	61	0.2879	101	0.7893
22	.0374	62	.2974	102	.8050
23	.0409	63	.3071	103	.8209
24	.0445	64	.3169	104	.8369
25	.0484	65	.3269	105	.8530
26	0.0523	66	0.3371	106	.8693
27	.0564	67	.3474	107	.8858
28	.0606	68	.3578	108	.9034
29	.0650	69	.3684	109	.9192
30	.0696	70	.3791	110	.9361
31	0.0743	71	0.3900	111	0.9532
32	.0794	72	.4011	112	0.9705
33	.0843	73	.4124	113	0.9880
34	.0895	74	.4238	114	1.0056
35	.0959	75	.4353	115	1.0233
36	0.1005	76	0.4469	116	1.0411
37	.1061	77	.4588	117	1.0591
38	.1118	78	.4708	118	1.0772
39	.1177	79	.4830	119	1.0955
40	.1238	80	.4953	120	1.1140

The use of this Table.

Example, *There is a Round Tun, whose Diametre is* 81 *Inches, and it is deep in the Liquor* 48 *Inches; how many Barrels is there in this Tun?*

Look for 81, the Diametre of the *Tun*, in the first Column of this *Table*, and right against it, you shall find this *Number*, 0.5077, which being Multiplyed by the *depth* of the *Liquor*, produceth 24.3696, which is 24 Barrels, and .3696 thousand parts of a *Barrel*, and so many *Barrels* is in the *Tun*.

See the Work.

The Diametre 81, —	0.5077
Depth of Liquor 48 Inch.	48
	40616
	20308
The Content in *Barrels*, and Parts,	24.3696

Now how much this .3696 Parts of a *Barrel* is, you are to take notice, That

1.0000	is	1 *Barrel*,
.5000		1 *Kilderkin*,
.2500		1 *Firkin*,
.0278		1 *Gallon*,
.0139		1 *Pottle*,
$.0069\frac{1}{2}$		1 *Quart*,
.0035		1 *Pint*,

Now look in this *Table* for .3696, or the nearest number to it, which is less, and that is .2500 and signifies 1 *Firkin*.— Subtract 2500 from .3696, and there remains .0096, which number look for in this *Table*, and the nearest to it is $69\frac{1}{2}$, which is 1 *Quart*; so that the *Liquor* contained in this *Tun*, is 24 *Barrels*, 1 *Firkin*, and 1 *Quart*, and somewhat more.

This is exactly true, when the *Tun* is all of one bigness, both at the top and bottom; but if it be narrower at the top than at the bottom, then the easiest way, (and exact enough) is, to take the Diametre of the *Tun* about the middle of it, or rather (if you can) at the middle of the *Liquor*: This may be called the *mean Diametre*, which being found in the first Column of this *Table*, and the Number standing against it, Multiplied by the depth of the *Liquor*, shall give the Content in *Barrels*.

Example 2, *Let the mean Diametre of a Tun be found to be (about the middle of the Liquor,)* 98 Inches, *and the depth of the Liquor* 76 Inches, *how many Barrels of Liquor is here in that Tun?*

The mean Diametre 98 Inches,		
The number against 98, is	—	0.7430
The depth of the *Liquor* 76 Inches	—	76
		44580
		52010
The Content,	— —	56.4680

Barrels	*Kil.*	*Fir.*	*Gal.*	*Pot.*	*Qu.*	*Pi.*
56	0	1	0	1	0	1

And so much *Liquor* is in the *Tun*.

A

A Table shewing the Content of any exact Square, or Oblong Brewer's Tun, in Barrels, and 10000 Parts of a Barrel.

The Length or Breadth of the Tun in Feet.

The Length or Breadth of the Tun in Feet.	XXI	XIX	XVIII	XVII	XVI	XV	XIV	XIII	XII	XI	*The Length or Breadth of the Tun in Feet.*
	B.parts	B.parts	B.parts	B.parts	B.parts	B.parts	B.parts	B.parts	B.parts	B.parts	
20	5.6739	5.3900	5.1164	4.8228	4.5392	4.2554	3.9716	3.6880	3.4044	3.1206	20
		5.1205	4.8511	4.5817	4.3122	4.0426	3.7731	3.5036	3.2340	2.5645	19
			4.5958	4.3406	4.0852	3.8298	3.5746	3.3192	3.0603	2 8084	18
	I			4.0994	3.8883	3.6172	3.3760	3.1343	2.8934	2.6524	17
1	0.0142	II			3.6314	3.4044	3.1774	2.9504	2.7232	2.4964	16
2	0.0284	0.0567	III			3.1916	2.9788	2.7660	2.5530	2.3303	15
3	0.0426	0.0851	0.1277	IV			2.7862	2.5816	2.3828	2.1842	14
4	0.0567	0.1135	0.1708	0.2270	V			2.3972	2.2126	2.0282	13
5	0.0709	0.1418	0.2128	0.2837	0.3546	VI			2.0244	1.8722	12
6	0.0851	0.1702	0.2553	0.3404	0.4255	0.5106	VII			1.7162	11
7	0.0993	0.1986	0.2979	0.3972	0.4905	0.5950	0.6951	VIII			
8	0.1135	0.2270	0.3424	0.4539	0.5674	0.6808	0.7944	0.9080	IX		
9	0.1277	0.2553	0.3830	0.5106	0.6383	0.7660	0.8937	1.0214	1.1489	X	
10	0.1418	0.2837	0.4255	0.5674	0.7092	0.8511	0.9929	1.1348	1.2766	1.4184	10
11	0.1560	0.3120	0.4680	0.6241	0.7801	0.9361	1.0921	1.2402	1.4042	1.5603	11
12	0.1702	0.3404	0.5106	0.6808	0.8510	1.0212	1.1914	1.3616	1.5318	1.7022	12
13	0.1844	0.3688	0.5532	0.7376	0.9220	1.1064	1.2908	1.4752	1.6596	1.8440	13
14	0.1985	0.3972	0.5958	0.7944	0.9929	1.1915	1.3901	1.5887	1.7873	1.9858	14
15	0.2128	0.4254	0.6383	0.8511	1.0639	1.2766	1.4894	1.7022	1.9149	2.1277	15
16	0.2269	0.4538	0.6809	0.9078	1.1348	1.3618	1.5887	1.8157	2.0426	2.2696	16
17	0.2411	0.4823	0.7234	0.9640	1.2057	1.4468	1.6880	1.9291	2.1703	2.4114	17
18	0.2533	0.5106	0.7659	1.0212	1.2766	1.5319	1.7872	2.0425	2.2979	2.5532	18
19	0.2695	0.5390	0.8085	1.0780	1.3475	1.6170	1.8865	2.1560	2.4255	2.6970	19
20	0.2837	0.5674	0.8511	1.1348	1.4184	1.7032	1.9859	2.2696	2.5532	2.8368	20
	I	II	III	IV	V	VI	VII	VIII	IX	X	

The use of this Table.

Example 1. *Let there be a square Tun, whose four sides are each of them 9 Foot, and it is 46 inches full of Liquor, how many Barrels of Liquor is there in this Tun?*

Look in the *top*, *bottom*, or *middle* of the *Table* for IX Foot, among the *Numeral Letters*, and also for 9 in either side of the *Table*, where you can find it among the *common figures*, and you shall find 9 in the left hand *Column*; then carry your finger along that Line from 9, till you come under IX in the middle of the *Table*, and the number under IX is 1.1489, which multiplied by 46 inches, (the depth of the Liquor,) the Product is 52.8494, which is 52 *Barrels*, and .8494 ten thousand parts of a *Barrel*, or 52 *Barrels*, 1 *Kilderkin*, 1 *Firkin*, 1 *Quart*, and a little more.

The number against 9, and under IX is	1.1489
The depth of the Liquor 46 inches,	46
	68934
	45956
Barrels,	52.8494

Example 2. *Let there be an Oblong, or Long-Square Tun, whose Length is 18 Foot, and Breadth is 12 Foot, and it is 35 Inches full of Liquor; how many Barrels is therein contained?*

Look for XII (the breadth of the Tun) at the head of the *Table*, and look down that Column till you come against 18 in the right side of the *Table*, and under XII, and against 18, you shall find this number 3.0003, which being multiplyed by 35 Inches, the depth of the Liquor, the Product will be 105.0105, which (4 figures being cut off) leaves 105 *Barrels*, and .0105 ten thousand parts of a *Barrel*, which is 1 Quart and 1 Pint; and so much Liquor is in the Tun.

The number between 18 and XII is	3.0003
The depth of Liquor 35 Inches,	35
	150015
	90009
The Content in *Barrels*,	105.0105

A Table shewing how much is wanting of a Beer Barrel, at every Inch, and a quarter of an Inch of Emptiness, both in Wine and Ale Gallons.

Dry Inches	Quart.	Beer Gall. Ga.	Pi.	100 pts.	Wine Gall. Ga.	Pi.	100 pts.
					0	0	00
0	0	0	0	00	0	0	49
	1	0	0	40	0	1	47
	2	0	1	20	0	2	57
	3	0	2	10	0	3	80
1	0	0	3	10	0	5	30
	1	0	4	33	0	7	35
	2	0	6	00	1	1	29
	3	0	7	60	1	4	00
2	0	1	1	80	1	6	56
	1	1	3	90	2	1	22
	2	1	6	10	2	4	34
	3	2	0	66	2	7	98
3	0	2	3	50	3	3	10
	1	2	6	16	3	6	20
	2	3	0	70	4	2	00
	3	3	3	80	4	5	30
4	0	3	6	50	5	1	35
	1	4	1	80	5	5	60
	2	4	5	25	6	1	45
	3	5	0	42	6	5	70
5	0	5	3	90	7	1	70
	1	5	7	20	7	6	20
	2	6	2	80	8	2	65
	3	6	6	50	8	7	20
6	0	7	2	20	9	3	20
	1	7	5	50	9	7	70
	2	8	1	10	10	4	20
	3	8	4	80	10	1	00
7	0	9	0	70	11	5	40
	1	9	4	50	12	2	20
	2	10	0	40	12	7	00
	3	10	4	30	13	4	10
8	0	11	0	50	14	0	80
	1	11	4	30	14	5	80
	2	12	0	30	15	2	80
	3	12	4	29	15	7	70
9	0	13	0	30	16	4	60
	1	13	4	30	17	1	60
	2	14	0	40	17	6	60
	3	14	4	60	18	3	40
10	0	15	0	50	19	0	30
	1	15	4	48	19	6	50
	2	16	0	80	20	3	25
	3	16	5	50	21	1	00
11	0	17	2	20	22	0	00
	1	17	7	90	22	6	98
	2	18	5	49	23	4	31
	3	19	2	00			

Inches	Quart.	Beer Gallons Gal.	Pi.	100 pts.	Wine Gallons Gal.	Pi.	100 pts.
12	0	19	6	16	24	1	48
	1	20	1	22	24	7	30
	2	20	7	40	25	4	60
	3	21	3	10	26	1	36
13	0	21	7	40	26	6	38
	1	22	3	00	27	3	36
	2	22	7	00	28	2	18
	3	23	3	00	25	5	18
14	0	23	7	30	29	2	20
	1	24	3	70	29	7	40
	2	24	7	40	30	3	90
	3	25	3	60	31	1	00
15	0	25	7	50	31	5	80
	1	26	3	30	32	2	60
	2	26	7	00	32	7	00
	3	27	3	00	33	3	80
16	0	27	6	40	34	0	30
	1	28	2	20	34	4	80
	2	28	5	80	35	0	80
	3	29	1	40	35	5	34
17	0	29	4	80	36	1	80
	1	30	0	40	36	6	29
	2	30	4	10	37	2	29
	3	30	7	50	37	6	54
18	0	31	3	00	38	2	39
	1	31	6	10	38	6	64
	2	32	1	80	39	2	70
	3	32	5	00	39	6	00
19	0	32	7	80	40	1	80
	1	33	2	10	40	4	90
	2	33	4	80	41	0	10
	3	33	7	40	41	3	65
20	0	34	2	00	41	6	77
	1	34	4	30	42	1	43
	2	34	6	20	42	4	00
	3	35	0	10	42	6	70
21	0	35	2	00	43	0	64
	1	35	3	60	43	2	70
	2	35	4	80	43	4	19
	3	35	6	00	43	5	42
22	0	35	6	80	43	6	51
	1	35	7	40	43	7	50
	2	36	0	00	44	0	00

The use of this Table.

The use of this Table is twofold.

1. *To know how much Liquor is in a Barrel, being partly full*: And

2. *To know how much the Barrel wants of being full.*

Example, Suppose the depth of the Liquor in the Barrel be 14 Inches, this taken from 22 Inches and a half, (the whole Diametre of the Barrel at the bung,) leaves 8 inches and half for the empty part. Wherefore, look in the Table for 8 inches and a half, against which you shall find 12 Gallons, 0 Pints, and 30 parts of a Pint; and so much doth the Barrel want of being full.— Also look in the Table for 14 inches, against which you shall find 23 Gallons, 7 Pints, and 30 parts of a Pint, and so much Liquor there is in the Barrel.— And these two being added together, do make 35 Gallons, 7 Pints, and 60 parts of a Pint, which is the whole content of the barrel in Ale Gallons within less than half a Pint.

Now if you would know the same in Wine Gallons, against 8 and a half (the empty part) here stands 14 Gallons, 5 Pints, 80 parts, and against 14 the full part, there stands 29 Gallons, 2 Pints, 20 parts, which added together, make 44 Gallons, the Content of the Barrel in Wine Gallons.

SECTION II.

Of the Mensuration of Timber-Trees, Growing, or Un-squared; And of the Works of the several Artificers Relating to the Building of Houses or other Edifices.

I. Of Timber Growing, or Un-squared.

IN the third Part of the Second Book hereof is taught how to measure all sorts of Regular Solids, and such are Timber and Stone when squared: But for Timber Growing or Un-squared there are several Customs used in the measuring of them upon Buying or Selling of them, as of Oak, Ash, Elm, &c.

1. In Buying of Oak Timber (where the Bark is pieled off) the Custom is, To take a Line, and girt about the middle of the Piece, and then to double the Line four Times, and account that *4th* part of the Girt, to be the Side of a Square equal to that Tree or Piece: But this way of measuring is egregiously false, (as hath been often detected;) for it makes the quantity of the Tree or Piece (be it great or little,) one fifth part less than it would be, were it truly measured.

Also in the measuring of Elm, Beech and Ash, whose Bark is on it, the Custom is, to cast away one Inch out of the *4th* part of the Girt, which may well be allowed when the Bark is three quarters of an Inch thick, and the Tree 40 Inches about; But if the Bark be thin, and the Tree less then 30 or 32 Inches about, then an Inch is too much to be allowed.

Illustration.

Suppose a Tree to be 4 Foot, or 48 Inches about, then the Diametre of that Tree will be $15\frac{1}{4}$ Inches, and one *4th* part thereof is 12 Inches: Now if you abate one Inch and a half of the Diametre for the Bark, then the Tree will be but $43\frac{1}{4}$ Inches about, whose *4th* part is not full 11 Inches; so that in this Case, one Inch may very well be abated from the *4th* part. So again, if the Bark be thinner, and the Tree lesser, a smaller allowance will serve: And if the Bark be thicker, and the Tree larger, there ought to be more allowed.

But this way of measuring by the *4th* part of the Girt, and allowing for the Bark, I say (as I did before) will prove to be just one fifth part over Measure: This being premised, and that the difference being as 4 to 5, let them look to it whom it may concern. And for the benefit of such as shall have occasion thereof, I have here inserted a Table, &c.

A Table shewing how much in length of any round Timber Tree, whose Circumference (or Girt) is known, doth make a Solid Foot of Timber, according to true Measure.

Inch. (The Circumference of the Tree in Inches.)	The length of a Foot Solid in — F.	in.	10p.	Inch. (The Circumference, &c.)	The length, &c. F.	in.	10p.	Inch. (The Circumference, &c.)	The length, &c. F.	in.	10p.	Inches. (The Circumference, &c.)	The length, &c. F.	in.	10p.
10	18	11	2	33	1	7	9	56	0	6	9	79	0	3	5
11	14	11	5	34	1	6	8	57	0	6	7	80	0	3	4
12	12	6	8	35	1	5	7	58	0	6	4	81	0	3	3
13	10	8	5	36	1	4	7	59	0	6	2	82	0	3	2
14	9	3	7	37	1	3	8	60	0	6	0	83	0	3	2
15	7	10	3	38	1	3	0	61	0	5	8	84	0	3	1
16	7	0	8	39	1	2	3	62	0	5	6	85	0	3	0
17	6	3	0	40	1	1	6	63	0	5	5	86	0	2	9
18	5	7	0	41	1	0	9	64	0	5	2	87	0	2	9
19	5	0	2	42	1	0	3	65	0	5	1	88	0	2	8
20	4	6	3	43	0	11	7	66	0	4	9	89	0	2	7
21	4	1	2	44	0	11	1	67	0	4	8	90	0	2	7
22	3	8	9	45	0	10	7	68	0	4	7	91	0	2	6
23	3	4	9	46	0	10	2	69	0	4	6	92	0	2	6
24	3	1	7	47	0	9	9	70	0	4	4	93	0	2	5
25	2	10	7	48	0	9	4	71	0	4	3	94	0	2	5
26	2	8	1	49	0	9	0	72	0	4	2	95	0	2	4
27	2	5	8	50	0	8	7	73	0	4	1	96	0	2	4
28	2	3	7	51	0	8	3	74	0	3	9	97	0	2	3
29	2	1	8	52	0	8	0	75	0	3	8	98	0	2	3
30	2	0	1	53	0	7	8	76	0	3	7	99	0	2	2
31	1	10	6	54	0	7	4	77	0	3	7	100	0	2	2
32	1	9	2	55	0	7	2	78	0	3	6				

The Use of this Table.

Example. *If a Timber Tree be 48 Inches about, how much in length thereof will make a Solid Foot of Timber?*

Look in the Column towards your left Hand for 48 Inches, against which stands 0. 9. 4. that is, no Feet, 9 Inches, and 4 tenth parts of an Inch: And so much in length, 48 Inches about, will make a Foot Solid.

Now if this Tree were 20 Foot (or 240 Inches) long, 9 Inches and 4 tenths of an Inch would be found 25 times and a half in that length; and so many Foot doth that Tree contain.

But if you take one fourth part of 48, which is 12 for the side of the Square equal, then this Tree would contain but just 20 foot, which is 5 foot and a half too little, which is above a fifth part, as was said before.

SECTION III.

Of the Measuring of the Works of the several Artificers relating to Building; and what Method and Customs are observed therein,

THE Principal Artificers relating to the Building of Houses and other Edifices, are the *Carpenter*, *Bricklayer*, *Plaisterer*, *Joyner*, *Painter*, *Glasier*, &c. of which, some of their Works are measured by the Square of Ten Foot (or 100 Foot.) Some by

by the Rod, Pole, or Pearch, (or 272 foot square,) some by the yard Superficial, (or 9 foot square, or yard Solid, containing 27 foot; some by the foot Superficial (of 144 inches,) or Solid, (of 1728 inches.)

Of the Carpenter's Work.

The Carpenters Works which are measurable, are Flooring, Partitioning, and Roofing: All which are measured by the square of 12 foot, so that one square contains 100 square feet.

1. *Of* **Flooring,**] *If a Floor be 57 foot 3 inches long, and 28 foot 6 inches broad, how many square of Flooring is there in that Room?*

Multiply 57 foot, 3 inches, by 28 foot, 6 inches, the Product will be 1631 foot, 7 ½ inches; that is, 16 square, 31 foot, or 16 square, 1 quarter, and 6 foot; for the 7 ½ inches, (in these works,) they are not to be regarded.

2. *Of* **Partitioning,**] *A Partition between Rooms being in length 82 foot, 6 inches, and in height 12 foot, 3 inches, how many square is therein?*

Multiply 82.5 foot, by 12.25 foot, the Product will be 1010.62 foot; that is, 10 square and 10 foot, the 62 or 7 ½ inches is neglected.

3. Of **Roofing,**] It is a Rule received among Work-men, that the flat of any house, and half the flat thereof, taken within the Walls, is equal to the measure of the *Roof* of the same house.

Example, *If a house within the Walls be 46 foot deep, and 18 foot broad; how many square of* Roofing *will cover that house?*

Multiply 46 by 28, the Product will be 828, and the half thereof is 414, which added to 128, the Summ is 1242; that is, 12 square, 42 foot, or 12 square, 1 quarter and 17 foot, and so many square will there be in the Roof.

Note, That 25 foot is 1 quarter, 50 is half, and 75 foot is 3 quarters of a square.

There are other Works about a Building done by the Carpenter, that are measured by the foot (Running measure,) that is, by the number of Feet in length only: As

Contaliver Cornice,	*Guttering,*	*Rails* and *Balasters,*
Modellion Cornice,	*Lintales,*	*Timber Front,*
Plain Cornice,	*Brest Somers,*	*Shelves, Dressers,*
Painthouse Cornice,	*Skirt board,*	*&c.*

There are also

Doors and Cases,	*Balcony Doors and Cases,*	*Stairs and Cases,*
Window Lights,	*Celler Doors and Cases,*	*Mantle-Trees and Tassels,*
Lutheren Lights,	*Columbs and Pilasters,*	*Pediments, &c.*

All which are Rated at —— *per* piece.

Note 1, In the measuring of flooring, after that you have measured the whole Floor, you must deduct out of it the Well-holes for the Stairs and Chimneys.—And in Partitioning for the Doors, *&c.* except, (by agreement) they are to be included.

Note 2. In measuring of Roofing, seldom any deductions are made for the holes for the Chimney Shafts, the Vacancies for Lutheren Lights, and Sky-Lights; they are more trouble to the Workman, then the Stuff which would cover them is worth.

Of the Bricklayer's Work.

The Principal are Tiling, Walling, and Chimney work,

1. Of **Tiling,**] Tiling is measured by the square of 10 foot: As Flooring, Partitioning, and Roofing in the Carpenters Work were; so that between the Roofing and the Tiling, the difference will not be much, yet the Tiling will be the most: For the Bricklayer sometimes will require to have running measure for Hyps and Valleys, which in some Cases may be allowed, but in most plain Roofs not.

An Example in this is needless.

2. For

2. For **Walling,**] Bricklayers do measure all their work by the Rod square, each Pole or Rod containing 16 foot and an half in length; so that one Rod in length, and one in breadth, do make a Rod square, containing upon the Superficies of the Wall 272 ¼ square feet; for 16.5 multiplied by 16.5, produceth 272.25.

Some other things are to be observed in the measuring of Brickwork; as the reducing thereof to a Standard thickness, for in Walls and Foundations of Houses, the Walls are of different thicknesses, which must be reduced to one, *viz.* to one brick and a half thick, as in *Examples* following.

Example 1, *If a Brick wall be 192 foot long, and 12 foot high, how many Rod of work is contained therein?*

Multiply 192 the length, by 12 the height, the Product will be 2304; and so many square feet are contained in the Superficies of the Wall, which divided by 272, (the number of Superficial feet in one Rod, for the quarter of 9 foot, we always reject,) the Quotient will be 8, and 128 remaining, which is 8 Rod, and the 128 foot, which divided by 68, (the feet in one quarter of a Rod,) the Quotient will be 1 Quarter of a Rod, and 60 foot remaining; so that the whole Wall contains 8 Rod, 1 quarter, and 60 foot, which is 8 Rod and a half wanting 8 foot.

Example 2. *If a Wall (or side of a House) be 24 foot, 6 inches long, and 37 foot, 8 inches broad; how many Rod is contained therein?*

Multiply 24.6 by 37.66, the Product will be 922.67, that is 922 foot, 9 inches, which we will call 923 foot; this divided by 272, the Quotient will be 3 Rod, and 107 remaining, which divided by 68, gives in the Quotient, 1 quarter, and 39 foot remaining: And this is the true content of this Wall, if it be all of one brick and a half thick from the top to the bottom.

But there is something else to be considered in the measuring of Brick-work, namely, the thickness of the Wall; for the thicker the Wall is, the more Rods are contained therein; for if the Wall be thicker then one Brick and a half, a square Rod (or 272 foot, will contain more than a Rod of Brick work, and a Rod of Wall which is less then one brick and half thick, will contain less than a Rod, when it is reduced to the Standard of one brick and a half thick.— So that every Rod measured upon the Superficies of a Wall that is 3 bricks thick, will contain two Rods being reduced; and one Rod upon a Wall of 4 bricks and a half thick, will contain three Rods, &c. wherefore for the ready reducing of brick work of any number of bricks thick, to the Standard of one and a half, take this general

RULE.

Multiply the number of Superficial feet, that are found to be contained upon the Superficies of any Wall, by the number of half bricks, which that Wall is in thickness; one third part of that Product shall be the content thereof reduced to the Standard of one brick and a half.

Example 3. *If a Wall be 72 foot long, 19 foot high, and 5 bricks and a half thick; how many Rods of brick work is contained therein, when reduced to Standard.*

Multiply 72 by 19, the Product will be 1368, and so many Superficial feet doth that Wall contain.— This multiplyed by 11, (the number of half bricks, that the Wall is thick) produceth 15048, one third part whereof is 5016; and so many feet doth the Wall contain, it being reduced to one brick and a half.— Lastly, Divide 5016, by 272, the Quotient will be 18 Rod, and 120 remaining, which divided by 68, the Quotient is 1 quarter, and 52 foot remaining; and that is the true content of that Wall, when reduced to a brick and a half thick, and so of any other.

	Long:	*High*	*Thick*		*R.*	*Q.*	*F.*
Thus if a Wall be	273	9	2	It will be found to contain Reduced.	12.	1.	44.
	45	16	3½		18.	2.	08.
	117	23	1		19.	3.	10.

Other

Other Bricklayers Works, viz.

Chimneys.] The Chimneys in most Building are agree'd for by the Hearth in each Room, and sometimes they are included in the Building, and paid for by the Rod, and measured with the rest of the Building, in this manner.—If the Chimney stand single, and alone, the usual way is to girt it about; and if the Jaums are but one Brick thick, and wraught upright over the Mantletree to the next Floor, then girt it about for a length, and the height of the story for a breadth, at one brick thick—But if the Chimney stand against a Wall that is before measured, then the breadth of the breast, and the depth of the two Jaums is the length, and the height of the story the breadth, at one brick and half, if the Jaums be so thick; and nothing to be deducted for the Area between the Hearth and Mantletree, because of the Wyths and thickning for the next Hearth above. For the Chimney Shafts, girt them about in the smallest place, for the breadth, and the height of the Shaft for the length, at one brick thick, in consideration of the Wyths, Pargetting, and Scaffolding, which is required for bringing them up.

Other Bricklayers Works which are measured by the Foot, running measure, are;

Cornices of all sorts,	Streight Arches,	Hyps and Valleys,
Facioes,	Skeen Arches,	Water Courses.

Other Works valued by the Piece, viz.

Pers, Pilasters, Rustick Work, Pediments, &c. There comes also to the Bricklayers Hands the Paving of Cellers, or the like, with Brick or Tiles, and for those they are paid for by the yard square.

Example 4. *If a Celler be paved with Brick or Tiles, which is 32 foot long, and 19 foot broad, How many yards of Paving is there in it?*

Multiply 32 by 19, the product will be 608, which divided by 9, the Quotient is 67 yards and 5 foot, which is above half a yard for the Content.

Note, That in the measuring of Brick work, if you take the Dimensions of the Sides of the House on the out-side, you must take the Dimensions of the Ends in the inside. And note also, that you must make Deductions for all Doors, Windows, &c.

Of the Plaisterers Works.

The Plaisterers Works are principally of two kinds, Namely, (1.) Work Lathed or Plaistered, which they call Cieling. (2.) Work Rendered, which is of two kinds, *viz.* Upon Brick Walls; or between Quarters in the Partitions between Room and Room; all which are measured by the Yard Square, or the Square of 3 foot; which is 9 foot.

1. Of **Cieling**] *If a Cieling be 58 foot 9 inches long, and 23 foot 7 inches broad, How many yards doth that Cieling contain?*

Multiply 58.75 foot, by 23.58 Foot, the Product will be 1385.32 foot, which divided by 9, the Quotient will be 154 yards *fere.*

2. Of **Partitioning**,] *If the Partitions, between Rooms be 132 foot about, and 12 foot high, How many yards in that Partition?*

Multiply 132 by 12, the Product is 1584, which divided by 9, gives in the Quotient 176 yards for the Content of the Partitions.

Note 1. If there be any Doors, Windows, or the like in your Partitioning, you must make deduction for them.

Note 2. When you measure rendring upon brick Walls, you are to make no Deductions, but when you measure rendring between Quarters, you may very well deduct one fifth part for the Quarters, Braces and Enterteices.

Note 3. That Whitning and Colouring are both measured by the yard, as the Ceiling and Rendring were; and as in Rendring between Quarters you deducted one fifth part, so in Whiting and Colouring you must add one fourth or fifth part at the least.

Of

Of the Joyners Works.

Joyners do measure their Work by the Yard Square or 9 Foot; but in the taking of their Dimensions they differ, for the Joyners have a Custom, and say, *We ought to measure where our Plane touches.* Wherefore, in the taking of the height of any Room, where there is a Cornice about, and swelling Pannels and Moldings downwards, they use, with a Line to girt over every Member of the Cornice, and Swellings of the Pannels and Moldings, which will make the Room much higher thna it is: Then for measuring about the Room they only take it as it is upon the Floor.

Example 1. *If a Room of Wainscot (being girt downwards) do contain in height* 15 *foot,* 7 *Inches, and be in compass about* 286 *foot, How many yards doth that Room contain?*

Multiply 286 foot by 15.58 foot, the Product will be 4456, which divided by 9, giveth in the Quotient 495 yards, and 1 foot, for the content of the Room in yards.

In Joyners Work there is another thing to be observed, that is in the measuring of Doors, Window-shutters, Cupboard-doors and Drawers, and such like, as are wrought on both sides; for these, they account to be paid for Work and half Work; for indeed the Work is (though not half, yet) more, although the Stuff be the same.

Example 2. *Let the Window Shutters about a Room be* 78 *foot* 4 *Inches, and the height of them* 6 *foot* 6 *Inches, How many yards are contained in these Shutters, at Work and half.*

Multiply 78.33 foot, dy 6.5 foot, the Product will be 509.14, the half whereof is 254.57, which added to 509.14, the Summ is 763.71 (or 764) which divided by 9, the Quotient is 85 yards *fere*, for the Content at Work and half Work.

Note, That you are to make Deductions for all Window Lights, but you must measure the Window-boards, the Sopheta-boards and Cheeks by themselves.

Of the Painters Works.

The taking of the Dimensions for the Painters Works is the same as that for the Joyners, by Girting of the Moldings, *&c.* And it is but reason that they should be paid for that upon which their Time and Colours are both expended. The Dimentions thus taken, the casting up, and reducing the Feet into Yards, is altogether the same as that of the Plaisters and Joyners: but the Painter never acquires Work and half Work, but reckons his Work Once, Twice or Thrice Primed, or Coloured over: I need give no Examples hereof, the foregoing being sufficient; Only take notice, that Window Lights, Window Bars, Casements, and such like things, they do them by the number at so much *per* Piece.

Of the Glaisiers Works.

Glasiers do measure their Work by the Foot Square; so that the length and breadth being multiplyed into each other, produceth the quantity of that Pain of Glass.

Example, *If a Pain of Glass be* 4 *foot* 9 *Inches long, and* 3 *foot* 3 *Inches broad, How many foot of Glass is contained in that Pain?*

Multiply 4.75 foot by 3.25 foot, the Product will be 15.44 foot, that is 15 foot 4 Inches and a quarter, and so many foot is contained in that Plain.

Note, That when Windows have half rounds at the top, they measure them at the full height as if they were square. Also Round or Oval Windows are measured at the full length and breadth of their Diametres. Likewise Crocket Windows in Stone-work are all measured by their full Squares: And there is reason for so doing: For the trouble in taking their Dimensions to work by, the waste of Glass in working, and the time expended in setting up, is far more than the Glass can be valued at.

Of the Masons Works.

Masons do measure all their Works by the Foot, either Superficial or Solid; and therefore I need give no Examples in their Works, for the Rules before delivered in Lib. 2. Part 1 hereof, for the measuring of Superficies and Solids, are sufficient to perform any Work done by the Mason in any case commensurable; And therefore I will give over Measuring for this time.

FINIS.

A
TRIANGULAR
CANON
Logarithmical:

CONTAINING

The *LOGARITHMS* of all absolute Numbers, from a Unite to 10000.

And of Artificial

SINES and TANGENTS

To every Degree and Minute of the Quadrant:

WITH THEIR

Complements ARITHMETICAL.

The Common Radius 10.0000000.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
1	0.0000000	21	1.3222193	41	1.6127838	61	1.7853298	81	1.9084850
2	0.3010300	22	1.3424227	42	1.6232493	62	1.7923917	82	1.9138138
3	0.4771212	23	1.3617278	43	1.6334684	63	1.7993405	83	1.9190781
4	0.6020600	24	1.3802112	44	1.6434527	64	1.8061800	84	1.9242793
5	0.6989700	25	1.3979400	45	1.6532125	65	1.8129133	85	1.9294189
6	0.7781512	25	1.4149733	46	1.6627578	66	1.8195439	86	1.9344984
7	0.8450980	27	1.4313638	47	1.6720978	67	1.8260748	87	1.9395192
8	0.9030900	28	1.4471580	48	1.6812412	68	1.8325089	88	1.9444827
9	0.9542425	29	1.4623980	49	1.6901961	69	1.8388491	89	1.9493900
10	1.0000000	30	1.4771212	50	1.6989700	70	1.8450980	90	1.9542425
11	1.0413927	31	1.4913617	51	1.7075702	71	1.8512583	91	1.9590414
12	1.0791812	32	1.5051500	52	1.7160033	72	1.8573325	92	1.9637878
13	1.1139433	33	1.5185139	53	1.7242759	73	1.8633229	93	1.9684829
14	1.1461280	34	1.5314789	54	1.7323937	74	1.8692317	94	1.9731278
15	1.1760912	35	1.5440680	55	1.7403627	75	1.8750613	95	1.9777236
16	1.2041200	36	1.5563025	56	1.7481880	76	1.8808136	96	1.9822712
17	1.2304489	37	1.5682017	57	1.7558748	77	1 8864907	97	1.9867717
18	1.2552725	38	1.5797836	58	1.7634280	78	1.8920946	58	1.9912261
19	1.2787536	39	1.5910646	59	1.7708520	79	1.8976271	99	1.9956352
20	1.3010299	40	1.6020600	60	1.7781512	80	1.9030894	100	2.0000000

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
101	2.0043213	161	2.2068259	221	2.3443923	281	2.4487063	341	2.5327544
102	2.0086002	162	2.2095150	222	2.3463530	282	2.4502491	342	2.5340261
103	2.0128372	163	2.2121876	223	2.3483049	283	2.4517864	343	2.5352941
104	2.0170333	164	2.2148438	224	2.3502480	284	2.4533183	344	2.5365584
105	2.0211893	165	2.2174839	225	2.3521825	285	2.4548449	345	2.5378191
106	2.0253059	166	2.2201081	226	2.3541084	286	2.4563660	346	2.5390761
107	2.0293838	167	2.2227164	227	2.3560258	287	2.4578819	347	2.5403295
108	2.0334237	168	2.2253093	228	2.3579348	288	2.4593925	348	2.5415792
109	2.0374265	169	2.2278867	229	2.3598355	289	2.4608978	349	2.5428254
110	2.0413927	170	2.2304489	230	2.3617278	290	2.4623980	350	2.5440680
111	2.0453230	171	2.2329961	231	2.3636120	291	2.4638930	351	2.5453071
112	2.0492180	172	2.2355284	232	2.3654880	292	2.4653828	352	2.5465427
113	2.0530784	173	2.2380461	233	2.3673559	293	2.4668676	353	2.5477747
114	2.0569048	174	2.2405492	234	2.3692158	294	2.4683473	354	2.5490033
115	2.0606978	175	2.2430380	235	2.3710679	295	2.4698220	355	2.5502283
116	2.0644580	176	2.2455127	236	2.3729120	296	2.4712917	356	2.5514500
117	2.0681859	177	2.2479733	237	2.3747483	297	2.4727564	357	2.5526682
118	2.0718820	178	2.2504200	238	2.3765769	298	2.4742163	358	2.5538830
119	2.0755470	179	2.2528530	239	2.3783979	299	2.4756712	359	2.5550944
120	2.0791812	180	2.2552725	240	2.3802112	300	2.4771212	360	2.5563025
121	2.0827854	181	2.2576786	241	2.3820170	301	2.4785665	361	2.5575072
122	2.0863598	182	2.2600714	242	2.3838154	302	2.4800069	362	2.5587086
123	2.0899051	183	2.2624511	243	2.3856063	303	2.4814426	363	2.5599066
124	2.0934217	184	2.2648178	244	2.3873898	304	2.4828736	364	2.5611014
125	2.0969100	185	2.2671717	245	2.3891661	305	2.4842998	365	2.5622929
126	2.1003705	186	2.2695129	246	2.3909351	306	2.4857214	366	2.5634811
127	2.1038037	187	2.2718416	247	2.3926969	307	2.4871384	367	2.5646661
128	2.1072100	188	2.2741578	248	2.3944517	308	2.4885507	368	2.5658478
129	2.1105897	189	2.2764618	249	2.3961993	309	2.4899585	369	2.5670264
130	2.1139433	190	2.2787536	250	2.3979400	310	2.4913617	370	2.5682017
131	2.1172713	191	2.2810334	251	2.3996737	311	2.4927604	371	2.5693739
132	2.1205739	192	2.2833012	252	2.4014005	312	2.4941546	372	2.5705429
133	2.1238516	193	2.2855573	253	2.4031205	313	2.4955443	373	2.5717088
134	2.1271048	194	2.2878017	254	2.4048337	314	2.4969296	374	2.5728716
135	2.1303338	195	2.2900346	255	2.4065402	315	2.4983105	375	2.5740313
136	2.1335389	196	2.2922561	256	2.4082400	316	2.4996871	376	2.5751878
137	2.1367206	197	2.2944662	257	2.4099331	317	2.5010593	377	2.5763413
138	2.1398791	198	2.2966652	258	2.4116197	318	2.5024271	378	2.5774918
139	2.1430148	199	2.2988531	259	2.4132998	319	2.5037907	379	2.5786392
140	2.1461280	200	2.3010300	260	2.4149733	320	2.5051500	380	2.5797836
141	2.1492191	201	2.3031960	261	2.4166405	321	2.5065050	381	2.5809250
142	2.1522883	202	2.3053514	262	2.4183013	322	2.5078559	382	2.5820634
143	2.1553360	203	2.3074960	263	2.4199557	323	2.5092025	383	2.5831988
144	2.1583625	204	2.3096302	264	2.4216039	324	2.5105450	384	2.5843312
145	2.1613680	205	2.3117539	265	2.4232459	325	2.5118834	385	2.5854607
146	2.1643528	206	2.3138672	266	2.4248816	326	2.5132176	386	2.5865873
147	2.1673173	207	2.3159703	267	2.4265113	327	2.5145477	387	2.5877110
148	2.1702617	208	2.3180633	268	2.4281348	328	2.5158738	388	2.5888317
149	2.1731863	209	2.3201463	269	2.4297523	329	2.5171959	389	2.5899496
150	2.1760912	210	2.3222193	270	2.4313638	330	2.5185139	390	2.5910646
151	2.1789769	211	2.3242824	271	2.4329693	331	2.5198280	391	2.5921767
152	2.1818436	212	2.3263359	272	2.4345689	332	2.5211381	392	2.5932861
153	2.1846914	213	2.3283796	273	2.4361626	333	2.5224442	393	2.5943925
154	2.1875207	214	2.3304138	274	2.4377506	334	2.5237465	394	2.5954962
155	2.1903317	215	2.3324384	275	2.4393327	335	2.5250448	395	2.5965971
156	2.1931246	216	2.3344537	276	2.4409091	336	2.5263393	396	2.5976952
157	2.1958996	217	2.3364597	277	2.4424798	337	2.5276299	397	2.5987905
158	2.1986571	218	2.3384565	278	2.4440448	338	2.5289167	398	2.5998831
159	2.2013971	219	2.3404441	279	2.4456042	339	2.5301997	399	2.6009729
160	2.2041200	220	2.3424227	280	2.4471580	340	2.5314789	400	2.6020600

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
401	2.6031444	461	2.6637009	521	2.7168377	581	2.7641761	641	2.8068580
402	2.6042260	462	2.6646420	522	2.7176705	582	2.7649230	642	2.8075350
403	2.6053050	463	2.6655810	523	2.7185017	583	2.7656685	643	2.8082110
404	2.6063814	464	2.6665180	524	2.7193313	584	2.7664128	644	2.8088859
405	2.6074550	465	2.6674529	525	2.7201593	585	2.7671559	645	2.8095597
406	2.6085260	466	2.6683859	526	2.7209857	586	2.7678976	646	2.8102325
407	2.6095944	467	2.6693169	527	2.7218106	587	2.7686381	647	2.8109043
408	2.6106602	468	2.6702458	528	2.7226339	588	2.7693773	648	2.8115750
409	2.6117233	469	2.6711728	529	2.7234557	589	2.7701153	649	2.8122447
410	2.6127838	470	2.6720978	530	2.7242759	590	2.7708520	650	2.8129133
411	2.6138418	471	2.6730209	531	2.7250945	591	2.7715875	651	2.8135810
412	2.6148972	472	2.6739420	532	2.7259116	592	2.7723217	652	2.8142476
413	2.6159500	473	2.6748611	533	2.7267272	593	2.7730547	653	2.8149132
414	2.6170003	474	2.6757783	534	2.7275412	594	2.7737864	654	2.8155777
415	2.6180481	475	2.6766936	535	2.7283538	595	2.7745170	655	2.8162413
416	2.6190933	476	2.6776069	536	2.7291648	596	2.7752462	656	2.8169038
417	2.6201360	477	2.6785184	537	2.7299743	597	2.7759743	657	2.8175654
418	2.6211763	478	2.6794279	538	2.7307823	598	2.7767012	658	2.8182259
419	2.6222140	479	2.6803355	539	2.7315888	599	2.7774268	659	2.8188854
420	2.6232493	480	2.6812412	540	2.7323937	600	2.7781512	660	2.8195439
421	2.6242821	481	2.6821451	541	2.7331973	601	2.7788745	661	2.8202014
422	2.6253124	482	2.6830470	542	2.7339993	602	2.7795965	662	2.8208580
423	2.6263404	483	2.6839471	543	2.7347998	603	2.7803173	663	2.8215135
424	2.6273658	484	2.6848454	544	2.7355989	604	2.7810369	664	2.8221681
425	2.6283889	485	2.6857417	545	2.7363965	605	2.7817554	665	2.8228216
426	2.6294096	486	2.6866363	546	2.7371926	606	2.7824726	666	2.8234742
427	2.6304279	487	2.6875290	547	2.7379873	607	2.7831887	667	2.8241258
428	2.6314438	488	2.6884198	548	2.7387805	608	2.7839036	668	2.8247765
429	2.6324573	489	2.6893088	549	2.7395723	609	2.7846173	669	2.8254261
430	2.6334684	490	2.6901961	550	2.7403627	610	2.7853298	670	2.8260748
431	2.6344773	491	2.6910815	551	2.7411516	611	2.7860412	671	2.8267225
432	2.6354837	492	2.6919651	552	2.7419391	612	2.7867514	672	2.8273693
433	2.6364879	493	2.6928469	553	2.7427251	613	2.7874605	673	2.8280151
434	2.6374897	494	2.6937269	554	2.7435098	614	2.7881684	674	2.8286599
435	2.6384892	495	2.6946052	555	2.7442930	615	2.7888751	675	2.8293038
436	2.6394865	496	2.6954817	556	2.7450748	616	2.7895807	676	2.8299467
437	2.6404814	497	2.6963564	557	2.7458552	617	2.7902852	677	2.8305887
438	2.6414741	498	2.6972293	558	2.7466342	618	2.7909885	678	2.8312297
439	2.6424645	499	2.6981005	559	2.7474118	619	2.7916906	679	2.8318698
440	2.6434527	500	2.6989700	560	2.7481880	620	2.7923917	680	2.8325089
441	2.6444386	501	2.6998377	561	2.7489629	621	2.7930916	681	2.8331471
442	2.6454223	502	2.7007037	562	2.7497363	622	2.7937904	682	2.8337844
443	2.6464037	503	2.7015689	563	2.7505084	623	2.7944880	683	2.8344207
444	2.6473830	504	2.7024305	564	2.7512791	624	2.7951846	684	2.8350561
445	2.6483600	505	2.7032914	565	2.7500484	625	2.7958800	685	2.8356906
446	2.6493348	506	2.7041505	566	2.7528164	626	2.7965743	686	2.8363241
447	2.6503075	507	2.7050079	567	2.7535830	627	2.7972675	687	2.8369567
448	2.6512780	508	2.7058637	568	2.7543483	628	2.7979596	688	2.8375884
449	2.6522463	509	2.7067178	569	2.7551123	629	2.7986506	689	2.8382192
450	2.6532125	510	2.7075702	570	2.7558748	630	2.7993405	690	2.8388491
451	2.6541765	511	2.7084209	571	2.7566361	631	2.8000293	691	2.8394780
452	2.6551384	512	2.7092700	572	2.7573960	632	2.8007171	692	2.8401061
453	2.6560982	513	2.7101174	573	2.7581546	633	2.8014037	693	2.8407332
454	2.6570558	514	2.7109631	574	2.7589119	634	2.8020892	694	2.8413595
455	2.6580114	515	2.7118072	575	2.7596678	635	2.8027737	695	2.8419848
456	2.6589648	516	2.7126497	576	2.7604225	636	2.8034571	696	2.8426092
457	2.6599162	517	2.7134905	577	2.7611758	637	2.8041394	697	2.8432328
458	2.6608655	518	2.7143297	578	2.7619278	638	2.8048207	698	2.8438554
459	2.6618127	519	2.7151673	579	2.7626786	639	2.8055008	699	2.8444772
460	2.6627578	520	2.7160033	580	2.7634280	640	3.8061800	700	2.8450980

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
701	2.8457180	761	2.8813846	821	2.9143431	881	2.9449759	941	2.9735896
702	2.8463371	762	2.8819550	822	2.9148718	882	2.9454686	942	2.9740509
703	2.8469553	763	2.8825245	823	2.9153998	883	2.9459607	943	2.9745117
704	2.8475726	764	2.8830933	824	2.9159272	884	2.9464523	944	2.9749720
705	2.8481891	765	2.8836614	825	2.9164539	885	2.9469433	945	2.9754318
706	2.8488047	766	2.8842288	826	2.9169800	886	2.9474337	946	2.9758911
707	2.8494194	767	2.8847954	827	2.9175055	887	2.9479236	947	2.9763500
708	2.8500332	768	2.8853612	828	2.9180303	888	2.9484139	948	2.9768083
709	2.8506462	769	2.8859263	829	2.9185545	889	2.9489018	949	2.9772662
710	2.8512583	770	2.8864907	830	2.9190781	890	2.9493900	950	2.9777236
711	2.8518696	771	2.8870544	831	2.9196010	891	2.9498777	951	2.9781805
712	2.8524800	772	2.8876173	832	2.9201233	892	2.9503648	952	2.9786369
713	2.8530895	773	2.8881795	833	2.9206450	893	2.9508514	953	2.9790929
714	2.8536982	774	2.8887410	834	2.9211660	894	2.9513375	954	2.9795484
715	2.8543060	775	2.8893017	835	2.9216865	895	2.9518230	955	2.9800034
716	2.9549130	776	2.8898617	836	2.9222063	896	2.9523080	956	2.9804579
717	2.8555191	777	2.8904210	837	2.9227254	897	2.9527924	957	2 9809119
718	2.8561244	778	2.8909796	838	2.9232440	898	2.9532763	958	2.9813655
719	2.8567289	779	2.8915374	839	2.9237620	899	2.9537597	959	2.9818186
720	2.8573325	780	2.8920946	840	2.9242793	900	2.9542425	960	2.9822712
721	2.8579353	781	2.8926510	841	2.9247960	901	2.9547248	961	2.9827234
722	2.8585372	782	2.8932067	842	2.9253121	902	2.9552065	962	2.9831751
723	2.8591383	783	2.8937618	843	2.9258276	903	2.9556877	963	2.9836263
724	2.8597386	784	2.8943161	844	2.9263424	904	2.9561684	964	2.9840770
725	2.8603380	785	2.8948696	845	2.9268567	905	2.9566486	965	2.9845273
726	2.8609366	786	2.8954225	846	2.9273704	906	2.9571282	966	2.9849771
727	2.8615344	787	2.8959747	847	2.9278834	907	2.9576073	967	2.9854265
728	2.8621314	788	2.8965262	848	2.9283958	908	2.9580858	968	2.9858753
729	2.8627275	789	2.8970770	849	2.9289077	909	2.9585639	969	2.9863238
730	2.8633229	790	2.8976271	850	2.9294189	910	2.9590414	970	2.9867717
731	2.8639174	791	2.8981765	851	2.9299296	911	2.9595184	971	2.9872192
732	2.8645111	792	2.8987252	852	2.9304396	212	2.9599948	972	2.9876663
733	2.8651040	793	2.8992732	853	2.9309490	913	2.9604708	973	2.9881128
734	2.8656960	794	2.8998205	854	2.9314579	914	2.9609462	974	2.9885589
735	2.8662873	795	2.9003671	855	2.9319661	915	2.9614211	975	2.9890046
736	2.8668778	796	2.9009131	856	2.9324738	916	2.9618955	976	2.9894498
737	2.8674675	797	2.9014583	857	2.9329808	917	2.9623693	977	2.9898946
738	2.8680564	798	2.9020029	858	2.9334873	918	2.9628427	978	2.9903388
739	2.8686444	799	2.9025468	859	2.9339932	919	2.9633155	979	2.9907827
740	2.8692317	800	2.9030900	860	2.9344984	920	2.9637878	980	2.9912261
741	2.8698182	801	2.9036325	861	2.9350031	921	2.9642596	981	2.9916690
742	2.8704039	802	2.9041744	862	2.9355073	922	2.9647309	982	2.9921115
743	2.8709888	803	2.9047155	863	2.9360108	923	2.9652017	983	2.9925535
744	2.8715729	804	2.9052560	864	2.9365137	924	2.9656720	984	2.9929951
745	2.8721563	805	2.9057959	865	2.9370161	925	2.9661417	985	2.9934362
746	2.8727388	806	2.9063350	866	2.9375179	926	2.9666110	986	2.9938769
747	2.8733206	807	2.9068735	867	2.9380191	927	2.9670797	987	2.9943171
748	2.8739016	808	2.9074114	868	2.9385197	928	2.9675480	988	2.9947569
749	2.8744818	809	2.9079485	869	2.9390198	929	2.9680157	989	2.9951963
750	2.8750613	810	2.9084850	870	2.9395192	930	2.9684829	990	2.9956352
751	2.8756399	811	2.9090208	871	2.9400181	931	2.9689497	991	2.9960736
752	2.8762178	812	2.9095560	872	2.9405165	932	2.9694159	992	2.9965117
753	2.8767950	813	2.9100905	873	2.9410142	933	2.9698816	993	2.9969492
754	2.8773713	814	2.9106244	874	2.9415114	934	2.9703469	994	2.9973864
755	2.8779469	815	2.9111576	875	2.9420080	935	2.9708116	995	2.9978231
756	2.8785218	816	2.9116901	876	2.9425041	936	2.9712758	996	2.9982593
757	2.8790959	817	2.9122220	877	2.9429996	937	2.9717396	997	2.9986951
758	2.8796692	818	2.9127533	878	2.9434945	938	2.9722028	998	2.9991305
759	2.8802418	819	2.9132839	879	2.9439889	939	2.9726656	999	2.9995655
760	2.8808136	820	2.9138138	880	2.9444827	940	2.9731278	1000	3.0000000

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
1001	3.0004341	1061	3.0257154	1121	3.0496056	1181	3.0722499	1241	3.0937718
1002	3.0008677	1062	3.0261245	1122	3.0499928	1182	3.0726175	1242	3.0941216
1003	3.0013009	1063	3.0265333	1123	3.0503797	1183	3.0729847	1243	3.0944711
1004	3.0017337	1064	3.0269416	1124	3.0507663	1184	3.0733517	1244	3.0948204
1005	3.0021661	1065	3.0273496	1125	3.0511525	1185	3.0737183	1245	3.0951693
1006	3.0025980	1066	3.0277572	1126	3.0515384	1186	3.0746847	1246	3.0955180
1007	3.0030295	1067	3.0281644	1127	3.0519239	1187	3.0744107	1247	3.0958664
1008	3.0034605	1068	3.0285712	1128	3.0523091	1188	3.0748164	1248	3.0962146
1009	3.0038912	1069	3.0289777	1129	3.0526939	1189	3.0751818	1249	3.0965624
1010	3.0043214	1070	3.0293838	1130	3.0530784	1190	3.0755470	1250	3.0969100
1011	3.0047512	1071	3.0297895	1131	3.0534626	1191	3.0759118	1251	3.0972573
1012	3.0051805	1072	3.0301948	1132	3.0538464	1192	3.0762762	1252	3.0976043
1013	3.0056094	1073	3.0305997	1133	3.0542299	1193	3.0766404	1253	3.0979511
1014	3.0060379	1074	3.0310043	1134	3.0546130	1194	3.0770043	1254	3.0982975
1015	3.0064660	1075	3.0314085	1135	3.0549959	1195	3.0773679	1255	3.0986437
1016	3.0068937	1076	3.0318123	1136	3.0553783	1196	3.0777312	1256	3.0989896
1017	3.0073209	1077	3.0322157	1137	3.0557605	1197	3.0780941	1257	3.0993353
1018	3.0077478	1078	3.0326188	1138	3.0561422	1198	3.0784568	1258	3.0996806
1019	3.0081742	1079	3.0330214	1139	3.0565237	1199	3.0788192	1259	3.1000257
1020	3.0086002	1080	3.0334237	1140	3.0569048	1200	3.0791812	1260	3.1003705
1021	3.0090257	1081	3.0338257	1141	3.0572856	1201	3.0795430	1261	3.1007151
1022	3.0094509	1082	3.0342273	1142	3.0576661	1202	3.0799045	1262	3.1010593
1023	3.0098756	1083	3.0346284	1143	3.0580462	1203	3.0802656	1263	3.1014033
1024	3.0102999	1084	3.0350293	1144	3.0584260	1204	3.0806265	1264	3.1017471
1025	3.0107239	1085	3.0354297	1145	3.0588055	1205	3.0809870	1265	3.1020905
1026	3.0111474	1086	3.0358298	1146	3.0591846	1206	3.0813473	1266	3.1024337
1027	3.0115704	1087	3.0362295	1147	3.0595634	1207	3.0817073	1267	3.1027766
1028	3.0119931	1088	3.0366289	1148	3.0599419	1208	3.0820669	1268	3.1031192
1029	3.0124154	1089	3.0370279	1149	3.0603200	1209	3.0824263	1269	3.1034616
1030	3.0128372	1090	3.0374265	1150	3.0606978	1210	3.0827854	1270	3.1038037
1031	3.0132587	1091	3.0378247	1151	3.0610753	1211	3.0831441	1271	3.1041455
1032	3.0136797	1092	3.0382226	1152	3.0614525	1212	3.0835026	1272	3.1044871
1033	3.0141003	1093	3.0386202	1153	3.0618293	1213	3.0838608	1273	3.1048284
1034	3.0145205	1094	3.0390173	1154	3.0622058	1214	3.0842187	1274	3.1051694
1035	3.0149403	1095	3.0394141	1155	3.0625820	1215	3.0845763	1275	3.1055102
1036	3.0153597	1096	3.0398105	1156	3.0629578	1216	3.0849336	1276	3.1058507
1037	3.0157787	1097	3.0402066	1157	3.0633333	1217	3.0852906	1277	3.1061909
1038	3.0161973	1998	3.0406023	1158	3.0637085	1218	3.0856473	1278	3.1065308
1039	3.0166155	1099	3.0409977	1159	3.0640834	1219	3.0860037	1279	3.1068705
1040	3.0170333	1100	3.0413927	1160	3.0644580	1220	3.0863598	1280	3.1072100
1041	3.0174507	1101	3.0417873	1161	3.0648322	1221	3.0867157	1281	3.1075491
1042	3.0178677	1102	3.0421816	1162	3.0652061	1222	3.0870712	1282	3.1078880
1043	3.0182843	1103	3.0425755	1163	3.0655797	1223	3.0874264	1283	3.1082266
1044	3.0187005	1104	3.0429691	1164	3.0659530	1224	3.0877814	1284	3.1085650
1045	3.0191163	1105	3.0433623	1165	3.0663259	1225	3.0881361	1285	3.1089031
1046	3.0195317	1106	3.0437551	1166	3.0666985	1226	3.0884905	1286	3.1092410
1047	3.0199467	1107	3.0441476	1167	3.0670708	1227	3.0888446	1287	3.1095785
1048	3.0203613	1108	3.0445398	1168	3.0674428	1228	3.0891984	1288	3.1099159
1049	3.0207755	1109	3.0449315	1169	3.0678145	1229	3.0895519	1289	3.1102529
1050	3.0211893	1110	3.0453230	1170	3.0681859	1230	3.0899051	1290	3.1105897
1051	3.0216027	1111	3.0457140	1171	3.0685569	1231	3.0902580	1291	3.1109262
1052	3.0220157	1112	3.0461048	1172	3.0689276	1232	3.0906107	1292	3.1112625
1053	3.0224284	1113	3.0464952	1173	3.0692980	1233	3.0909631	1293	3.1115985
1054	3.0228406	1114	3.0468852	1174	3.0696681	1234	3.0913151	1294	3.1119343
1055	3.0232524	1115	3.0472749	1175	3.0700379	1235	3.0916669	1295	3.1122698
1056	3.0236639	1116	3.0476642	1576	3.0704073	1236	3.0920185	1296	3.1126050
1057	3.0240750	1117	3.0480532	1177	3.0707765	1237	3.0923697	1297	3.1129400
1058	3.0244857	1118	3.0484418	1178	3.0711453	1238	3.0927206	1298	3.1132746
1059	3.0248960	1119	3.0488301	1179	3.0715138	1239	3.0930712	1299	3.1136091
1060	3.0253059	1120	3.0492180	1180	3.0718820	1240	3.0934217	1300	3.1139433

CHILIAS II.

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
1301	3.1142773	1361	3.1338581	1421	3.1525941	1481	3.1705550	1541	3.1878026
1302	3.1146110	1362	3.1341771	1422	3.1528996	1482	3.1708482	1541	3.1880844
1303	3.1149444	1363	3.1344958	1423	3.1532049	1483	3.1711411	1543	3.1883659
1304	3.1152776	1364	3.1348144	1424	3.1535100	1484	3.1714339	1544	3.1886473
1305	3.1156105	1365	3.1351326	1425	3.1538149	1485	3.1717264	1545	3.1889285
1306	3.1159432	1366	3.1354507	1426	3.1541195	1486	3.1720188	1546	3.1892095
1307	3.1162756	1367	3.1357685	1427	3.1544240	1487	3.1723110	1547	3.1894903
1308	3.1166077	1368	3.1360861	1428	3.1547282	1488	3.1726029	1548	3.1897709
1309	3.1169396	1369	3.1364034	1429	3.1550322	1489	3.1728947	1549	3.1900514
1310	3.1172713	1370	3.1367206	1430	3.1553360	1490	3.1731863	1550	3.1903317
1311	3.1176027	1371	3.1370374	1431	3.1556396	1491	3.1734776	1551	3.1906118
1312	3.1179338	1372	3.1373541	1432	3.1559430	1492	3.1737688	1552	3.1908917
1313	3.1182647	1373	3.1376705	1433	3.1562462	1493	3.1740598	1553	3.1911714
1314	3.1185954	1374	3.1379867	1434	3.1565491	1494	3.1743506	1554	3.1914510
1315	3.1189257	1375	3.1383027	1435	3.1568519	1495	3.1746412	1555	3.1917304
1316	3.1192559	1376	3.1386184	1436	3.1571544	1496	3.1749316	1556	3.1920096
1317	3.1195858	1377	3.1389339	1437	3.1574568	1497	3.1752218	1557	3.1922886
1318	3.1199154	1378	3.1392492	1438	3.1577589	1498	3.1755118	1558	3.1925674
1319	3.1202448	1379	3.1395643	1439	3.1580608	1499	3.1758016	1559	3.1928461
1320	3.1205739	1380	3.1398791	1440	3.1583625	1500	3.1760912	1560	3.1931246
1321	3.1209028	1381	3.1401937	1441	3.1586640	1501	3.1763807	1561	3.1934029
1322	3.1212314	1382	3.1405080	1442	3.1589653	1502	3.1766699	1562	3.1936810
1323	3.1215598	1383	3.1408222	1443	3.1592663	1503	3.1769590	1563	3.1939590
1324	3.1218880	1384	3.1411361	1444	3.1595672	1504	3.1772478	1564	3.1942367
1325	3.1222159	1385	3.1414498	1445	3.1598678	1505	3.1775365	1565	3.1945143
1326	3.1225435	1386	3.1417632	1446	3.1601683	1506	3.1778250	1566	3.1947917
1327	3.1228709	1387	3.1420765	1447	3.1604685	1507	3.1781132	1567	3.1950690
1328	3.1231981	1388	3.1423895	1448	3.1607686	1508	3.1784013	1568	3.1953460
1329	3.1235250	1389	3.1427022	1449	3.1610684	1509	3.1786892	1569	3.1956229
1330	3.1238516	1390	3.1430148	1450	3.1613680	1510	3.1789769	1570	3.1958996
1331	3.1241780	1391	3.1433271	1451	3.1616674	1511	3.1792645	1571	3.1961762
1332	3.1245042	1392	3.1436392	1452	3.1619666	1512	3.1795518	1572	3.1964525
1333	3.1248301	1393	3.1439511	1453	3.1622656	1513	3.1798389	1573	3.1967287
1334	3.1251558	1394	3.1442628	1454	3.1625644	1514	3.1801259	1574	3.1970047
1335	3.1254813	1395	3.1445742	1455	3.1628630	1515	3.1804126	1575	3.1972805
1336	3.1258064	1396	3.1448854	1456	3.1631614	1516	3.1806992	1576	3.1975562
1337	3.1261314	1397	3.1451964	1457	3.1634595	1517	3.1809856	1577	3.1978317
1338	3.1264561	1398	3.1455072	1458	3.1637575	1518	3.1812718	1578	3.1981070
1339	3.1267805	1399	3.1458177	1459	3.1640553	1519	3.1815578	1579	3.1983821
1340	3.1271048	1400	3.1461280	1460	3.1643528	1520	3.1818436	1580	3.1986571
1341	3.1274288	1401	3.1464381	1461	3.1646502	1521	3.1821292	1581	3.1989319
1342	3.1277525	1402	3.1467480	1462	3.1649474	1522	3.1824146	1582	3.1992065
1343	3.1280760	1403	3.1470577	1463	3.1652443	1523	3.1826999	1583	3.1994809
1344	3.1283993	1404	3.1473671	1464	3.1655411	1524	3.1829850	1584	3.1997552
1345	3.1287223	1405	3.1476763	1465	3.1658376	1525	3.1832698	1585	3.2000293
1346	3.1290450	1406	3.1479853	1466	3.1661340	1526	3.1835545	1586	3.2003032
1347	3.1293676	1407	3.1482941	1467	3.1664301	1527	3.1838390	1587	3.2005769
1348	3.1296899	1408	3.1486026	1468	3.1667260	1528	3.1841233	1588	3.2008505
1349	3.1300119	1409	3.1489110	1469	3.1670218	1529	3.1844075	1589	3.2011239
1350	3.1303338	1410	3.1492191	1470	3.1673173	1530	3.1846914	1590	3.2013971
1351	3.1306553	1411	3.1495270	1471	3.1676127	1531	3.1849752	1591	3.2016701
1352	3.1309767	1412	3.1498347	1472	3.1679078	1532	3.1852588	1592	3.2019430
1353	3.1312978	1413	3.1501422	1473	3.1682027	1533	3.1855421	1593	3.2022158
1354	3.1316187	1414	3.1504494	1474	3.1684975	1534	3.1858253	1594	3.2024883
1355	3.1319393	1415	3.1507564	1475	3.1687920	1535	3.1861084	1595	3.2027507
1356	3.1322597	1416	3.1510632	1476	3.1690863	1536	3.1863912	1596	3.2030329
1357	3.1325798	1417	3.1513698	1477	3.1693805	1537	3.1866739	1597	3.2033049
1358	3.1328998	1418	3.1516762	1478	3.1696744	1538	3.1869563	1598	3.2035768
1359	3.1332194	1419	3.1519824	1479	3.1699682	1539	3.1872386	1599	3.2038485
1360	3.1335389	1420	3.1522883	1480	3.1702617	1540	3.1875207	1600	3.2041200

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
1601	3.2043913	1661	3.2203696	1721	3.2357809	1781	3.2506639	1841	3.2650538
1602	3.2046625	1662	3.2206310	1722	3.2360331	1782	3.2509077	1842	3.2652896
1603	3.2049335	1663	3.2208922	1723	3.2362853	1783	3.2511513	1843	3.2655253
1604	3.2052044	1664	3.2211533	1724	3.2365373	1784	3.2513948	1844	3.2657609
1605	3.2054750	1665	3.2214142	1725	3.2367891	1785	3.2516382	1845	3.2659964
1606	3.2057455	1666	3.2216750	1726	3.2370408	1786	3.2518814	1846	3.2662317
1607	3.2060159	1667	3.2219356	1727	3.2372923	1787	3.2521245	1847	3.2664699
1608	3.2062860	1668	3.2221960	1728	3.2375437	1788	3.2523675	1848	3.2667020
1609	3.2065560	1669	3.2224563	1729	3.2377950	1789	3.2526103	1849	3.2669369
1610	3.2068259	1670	3.2227165	1730	3.2380461	1790	3.2528530	1850	3.2671717
1611	3.2070955	1671	3.2229764	1731	3.2382971	1791	3.2530956	1851	3.2674064
1612	3.2073650	1672	3.2232363	1732	3.2385479	1792	3.2533380	1852	3.2676410
1613	3.2076344	1673	3.2234959	1733	3.2387986	1793	3.2535803	1853	3.2678754
1614	3.2079035	1674	3.2237554	1734	3.2390491	1794	3.2538224	1854	3.2681097
1615	3.2081725	1675	3.2240148	1735	3.2392995	1795	3.2540644	1855	3.2683439
1616	3.2084413	1676	3.2242740	1736	3.2395497	1796	3.2543063	1856	3.2685780
1617	3.2087100	1677	3.2245331	1737	3.2397998	1797	3.2545480	1857	3.2688119
1618	3.2089785	1678	3.2247919	1738	3.2400498	1798	3.2547897	1858	3.2690457
1619	3.2092468	1679	3.2250507	1739	3.2402996	1799	3.2550312	1859	3.2692794
1620	3.2095150	1680	3.2253093	1740	3.2405492	1800	3.2552725	1860	3.2605129
1621	3.2097830	1681	3.2255677	1741	3.2407988	1801	3.2555137	1861	3.2697464
1622	3.2100508	1682	3.2258260	1742	3.2410481	1802	3.2557548	1862	3.2699797
1623	3.2103185	1683	3.2260841	1743	3.2412974	1803	3.2559957	1863	3.2702128
1624	3.2105860	1684	3.2263420	1744	3.2415465	1804	3.2562365	1864	3.2704459
1625	3.2108534	1685	3.2265999	1745	3.2417954	1805	3.2564772	1865	3.2706788
1626	3.2111205	1686	3.2268576	1746	3.2420442	1806	3.2567177	1866	3.2709116
1627	3.2113875	1687	3.2271151	1747	3.2422929	1807	3.2569581	1867	3.2711443
1628	3.2116544	1688	3.2273724	1748	3.2425414	1808	3.2571984	1868	3.2713769
1629	3.2119211	1589	3.2276296	1749	3.2427898	1809	3.2574386	1869	3.2716093
1630	3.2121876	1690	3.2278867	1750	3.2430380	1810	3.2576786	1870	3.2718416
1631	3.2124540	1691	3.2281436	1751	3.2432861	1811	3.2579184	1871	3.2720738
1632	3.2127201	1692	3.2284003	1752	3.2435341	1812	3.2581582	1872	3.2723058
1633	3.2129862	1693	3.2286569	1753	3.2437819	1813	3.2583978	1873	3.2725378
1634	3.2132520	1694	3.2289134	1754	3.2440296	1814	3.2586373	1874	3.2727696
1635	3.2135177	1695	3.2291697	1755	3.2442771	1815	3.2588766	1875	3.2730013
1636	3.2137833	1696	3.2294258	1756	3.2445245	1816	3.2591158	1876	3.2732328
1637	3.2140487	1697	3.2296818	1757	3.2447718	1817	3.2593549	1877	3.2734643
1638	3.2143139	1698	3.2299377	1758	3.2450189	1818	3.2595939	1878	3.2736956
1639	3.2145789	1699	3.2301934	1759	3.2452658	1819	3.2598327	1879	3.2739268
1640	3.2148438	1700	3.2304489	1760	3.2455127	1820	3.2600714	1880	3.2741578
1641	3.2151086	1701	3.2307043	1761	3.2457593	1821	3.2603099	1881	3.2743888
1642	3.2153731	1702	3.2309595	1762	3.2460059	1822	3.2605484	1882	3.2746196
1643	3.2156376	1703	3.2312146	1763	3.2462523	1823	3.2607867	1883	3.2748503
1644	3.2159018	1704	3.2314696	1764	3.2464986	1824	3.2610248	1884	3.2750809
1645	3.2161659	1705	3.2317244	1765	3.2467447	1825	3.2612529	1885	3.2753113
1646	3.2164298	1706	3.2319790	1766	3.2469907	1826	3.2615008	1886	3.2755417
1647	3.2166936	1707	3.2322335	1767	3.2472365	1827	3.2617385	1887	3.2757719
1648	3.2169572	1708	3.2324879	1768	3.2474823	1828	3.2619762	1888	3.2760020
1649	3.2172206	1709	3.2327421	1769	3.2477278	1829	3.2622137	1889	3.2762319
1650	3.2174839	1710	3.2329961	1770	3.2479733	1830	3.2624511	1890	3.2764618
1651	3.2177471	1711	3.2332500	1771	3.2482186	1831	3.2626883	1891	3.2766915
1652	3.2180100	1712	3.2335038	1772	3.2484637	1832	3.2629255	1892	3.2769211
1653	3.2182728	1713	3.2337574	1773	3.2487087	1833	3.2631625	1893	3.2771506
1654	3.2185355	1714	3.2340108	1774	3.2489536	1834	3.2633993	1894	3.2773800
1655	3.2187980	1715	3.2342641	1775	3.2491983	1835	3.2636361	1895	3.2776092
1656	3.2190603	1716	3.2345173	1776	3.2494430	1836	3.2638727	1896	3.2778383
1657	3.2193225	1717	3.2347703	1777	3.2496874	1837	3.2641091	1897	3.2780673
1658	3.2195845	1718	3.2350231	1778	3.2499317	1838	3.2643455	1898	3.2782962
1659	3.2198464	1719	3.2352759	1779	3.2501759	1839	3.2645817	1899	3.2785250
1660	3.2201081	1720	3.2355284	1780	3.2504200	1840	3.2648178	1900	3.2787536

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
1901	3.2789821	1961	3.2924776	2021	3.3055653	2081	3.3182721	2141	3.3306167
1902	3.2792105	1962	3.2926990	2022	3.3057811	2082	3.3184807	2142	3.3308195
1903	3.2794388	1963	3.2929203	2023	3.3059959	2083	3.3186893	2143	3.3310222
1904	3.2796669	1964	3.2931415	2024	3.3062105	2084	3.3188977	2144	3.3312248
1905	3.2798950	1965	3.2933625	2025	3.3064250	2085	3.3191060	2145	3.3314273
1906	3.2801229	1966	3.2935835	2026	3.3066394	2086	3.3193143	2146	3.3316297
1907	3.2803507	1967	3.2938043	2027	3.3068537	2087	3.3195224	2147	3.3318320
1908	3.2805784	1968	3.2940251	2028	3.3070679	2088	3.3197305	2148	3.3320343
1909	3.2808059	1969	3.2942457	2029	3.3072820	2089	3.3199384	2149	3.3322364
1910	3.2810334	1970	3.2944662	2030	3.3074960	2090	3.3201463	2150	3.3324384
1911	3.2812607	1971	3.2946866	2031	3.3077099	2091	3.3203540	2151	3.3326404
1912	3.2814879	1972	3.2949069	2032	3.3079237	2092	3.3205617	2152	3.3328423
1913	3.2817150	1973	3.2951271	2033	3.3081374	2093	3.3207692	2153	3.3330440
1914	3.2819419	1974	3.2953471	2034	3.3083509	2094	3.3209767	2154	3.3332457
1915	3.2821683	1975	3.2955671	2035	3.3085644	2095	3.3211840	2155	3.3334473
1916	3.2823955	1976	3.2957869	2036	3.3087778	2096	3.3213913	2156	3.3336487
1917	3.2826221	1977	3.2960067	2037	3.3089910	2097	3.3215984	2157	3.3338501
1918	3.2828486	1978	3.2962263	2038	3.3092042	2098	3.3218055	2158	3.3340514
1919	3.2830750	1979	3.2964458	2039	3.3094172	2099	3.3220124	2159	3.3342526
1920	3.2833012	1980	3.2966652	2040	3.3096302	2100	3.3222193	2160	3.3344537
1921	3.2835274	1981	3.2968845	2041	3.3098430	2101	3.3224260	2161	3.3346548
1922	3.2837534	1982	3.2971036	2042	3.3100557	2102	3.3226327	2162	3.3348557
1923	3.2839793	1983	3.2973227	2043	3.3102684	2103	3.3228393	2163	3.3350565
1924	3.2842051	1984	3.2975417	2044	3.3104809	2104	3.3230457	2164	3.3352572
1925	3.2844307	1985	3.2977605	2045	3.3106933	2105	3.3232521	2165	3.3354579
1926	3.2846563	1986	3.2979792	2046	3.3109056	2106	3.3234584	2166	3.3356584
1927	3.2848817	1987	3.2981979	2047	3.3111178	2107	3.3236645	2167	3.3358589
1928	3.2851070	1988	3.2984164	2048	3.3113299	2108	3.3238706	2168	3.3360593
1929	3.2853322	1989	3.2986348	2049	3.3115419	2109	3.3240766	2169	3.3362595
1930	3.2855573	1990	3.2988531	2050	3.3117539	2110	3.3242824	2170	3.3364597
1931	3.2857823	1991	3.2990713	2051	3.3119657	2111	3.3244882	2171	3.3366598
1932	3.2860071	1992	3.2992893	2052	3.3121773	2112	3.3246939	2172	3.3368598
1933	3.2862318	1993	3.2995073	2053	3.3123889	2113	3.3248995	2173	3.3370597
1934	3.2864565	1994	3.2997251	2054	3.3126004	2114	3.3251050	2174	3.3372595
1935	3.2866810	1995	3.2999429	2055	3.3128118	2115	3.3253104	2175	3.3374593
1936	3.2869053	1996	3.3001605	2056	3.3130231	2116	3.3255157	2176	3.2376589
1937	3.2871296	1997	3.3003781	2057	3.3132343	2117	3.3257208	2177	3.3378584
1938	3.2873538	1998	3.3005955	2058	3.3134454	2118	3.3259259	2178	3.3380579
1939	3.2875778	1999	3.3008128	2059	3.3136563	2119	3.3261309	2179	3.3382572
1940	3.2878017	2000	3.3010300	2060	3.3138672	2120	3.3263359	2180	3.3384565
1941	3.2880255	2001	3.3012471	2061	3.3140780	2121	3.3265407	2181	3.3386557
1942	3.2882492	2002	3.3014641	2062	3.3142887	2122	3.3267454	2182	3.3388547
1943	3.2884728	2003	3.3016809	2063	3.3144992	2123	3.3269500	2183	3.3390537
1944	3.2886963	2004	3.3018977	2064	3.3147097	2124	3.3271545	2184	3.3392526
1945	3.2889196	2005	3.3021144	2065	3.3149200	2125	3.3273589	2185	3.3394514
1946	3.2891428	2006	3.3023309	2066	3.3151303	2126	3.3275633	2186	3.3396501
1947	3.2893659	2007	3.3025474	2067	3.3153405	2127	3.3277675	2187	3.3398488
1948	3.2895889	2008	3.3027637	2068	3.3155505	2128	3.3279716	2188	3.3400473
1949	3.2898118	2009	3.3029799	2069	3.3157605	2129	3.3281757	2189	3.3402458
1950	3.2900346	2010	3.3031960	2070	3.3159703	2130	3.3283796	2190	3.3404441
1951	3.2902573	2011	3.3034121	2071	3.3161801	2131	3.3285834	2191	3.3406424
1952	3.2904798	2012	3.3036280	2072	3.3163897	2132	3.3287872	2192	3.3408405
1953	3.2907022	2013	3.3038438	2073	3.3165993	2133	3.3289908	2193	3.3410386
1954	3.2909245	2014	3.3040595	2074	3.3168087	2134	3.3291944	2194	3.3412366
1955	3.2911468	2015	3.3042750	2075	3.3170181	2135	3.3293979	2195	3.3414345
1956	3.2913688	2016	3.3044905	2076	3.3172273	2136	3.3296012	2196	3.3416323
1957	3.2915908	2017	3.3047059	2077	3.3174365	2137	3.3298045	2197	3.3418300
1958	3.2918127	2018	3.3049211	2078	3.3176455	2138	3.3300077	2198	3.3420277
1959	3.2920344	2019	3.3051363	2079	3.3178545	2139	3.3302108	2199	3.3422252
1960	3.2922561	2020	3.3053514	2080	3.3180633	2140	3.3304138	2200	3.3424227

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
2201	3.3426200	2261	3.3543006	2321	3.3656751	2381	3.3757594	2441	3 4875678
2202	3.3428173	2262	3.3544926	2322	3.3658622	2382	3.3759417	2442	3.3877456
2203	3.3430145	2263	3.3546845	2323	3.3660492	2383	3.3771240	2443	3.3879235
2204	3.3432116	2264	3.3548764	2324	3.3662361	2384	3.3773062	2444	3 3881012
2205	3.3434086	2265	3.3550682	2325	3.3664229	2385	3.3774884	2445	3.4882789
2206	3.3436055	2266	3.3552599	2326	3.3666097	2386	3.3776704	2446	3.3884564
2207	3.3438023	2267	3.3554515	2327	3.3667964	2387	3.3778524	2447	3.3886340
2208	3.3439991	2268	3.3556430	2328	3.3669830	2388	3.3780343	2448	3.3888114
2209	3.3441957	2269	3.3558345	2329	3.3671695	2389	3.3782161	2449	3.3889888
2210	3.3443923	2270	3.3560258	2330	3.3673559	2390	3.3783979	2450	3.3891661
2211	3.3445887	2271	3.3562171	2331	3.3675423	2391	3.3785796	2451	3.3893433
2212	3.3447851	2272	3.3564083	2332	3.3677285	2392	3.3787612	2452	3.3895205
2213	3.3449814	2273	3.3565994	2333	3.3679147	2393	3.3789427	2453	3.3896975
2214	3.3451776	2274	3.3567905	2334	3.3681008	2394	3.3791241	2454	3.3898745
2215	3.3453737	2275	3.3569814	2335	3.3682869	2395	3.3793055	2455	3.3900515
2216	3.3455697	2276	3.3571722	2336	3.3684728	2396	3.3794868	2456	3.3902234
2217	3.3457657	2277	3.3573630	2337	3.3686587	2397	3 3796680	2457	3.3904051
2218	3.3459615	2278	3.3575537	2338	3.3688445	2398	3.3798492	2458	3.3905819
2219	3.3461573	2279	3.3577443	2339	3.3690302	2399	3.3800302	2459	3.3907585
2220	3.3463530	2280	3.3579348	2340	3.3692158	2400	3.3802112	2460	3.3909351
2221	3 3465485	2281	3.3581253	2341	3.3694014	2401	3.3803922	2461	3.3911116
2222	3.3467440	2282	3.3583156	2342	3.3695869	2402	3.3805730	2462	3.3912880
2223	3.3469395	2283	3.3585059	2343	3.3697723	2403	3.3807538	2463	3.3914644
2224	3.3471348	2284	3.3586961	2344	3.3699576	2404	3.3809345	2464	3.3916407
2225	3.3473300	2285	3.3588862	2345	3.3701428	2405	3.3811151	2465	3.3918169
2226	3.3475252	2286	3.3590762	2346	3.3703280	2406	3.3812956	2466	3.3919931
2227	3.3477202	2287	3.3592662	2347	3.3705131	2407	3.3814761	2467	3.3921691
2228	3.3479152	2288	3.3594560	2348	3.3706981	2408	3.3816565	2468	3.3923451
2229	3.3481101	2289	3.3596458	2349	3.3708830	2409	3.3818368	2469	3.3925211
2230	3.3483049	2290	3.3598355	2350	3.3710679	2410	3 3820170	2470	3.3926969
2231	3.3484996	2291	3.3600251	2351	3.3712526	2411	3.3821972	2471	3.3928727
2232	3.3486942	2292	3.3602146	2352	3.3714373	2412	3.3823773	2472	3.3930485
2233	3.3488887	2293	3.3604040	2353	3.3716219	2413	3.3825573	2473	3.3932241
2234	3.3490832	2294	3.3605934	2354	3.3718064	2414	3.3827373	2474	3.3933997
2235	3.3492775	2295	3.3607827	2355	3.3719909	2415	3.3829171	2475	3.3935752
2236	3.3494718	2296	3.3609719	2356	3.3721753	1416	3.3830969	2476	3.3937506
2237	3.3496660	2297	3.3611610	2357	3.3723596	2417	3.3832766	2477	3.3939260
2238	3.3498601	2298	3.3613500	2358	3.3725438	2418	3.3834563	2478	3 3941013
2239	3.3500541	2299	3.3615390	2359	3.3727279	2419	3.3836359	2479	3.3942765
2240	3.3502480	2300	3.3617278	2360	3.3729120	2420	3.3838154	2480	3.3944517
2241	3.3504418	2301	3.3619166	2361	3.3730960	2421	3.3839948	2481	3.3946268
2242	3.3506356	2302	3.3621053	2362	3.3732799	2422	3.3841741	2482	3.3948018
2243	3.3508293	2303	3.3622939	2363	3.3734637	2423	3.3843534	2483	3.3949767
2244	3.3510228	2304	3.3624825	2364	3.3736475	2424	3.3845326	2484	3.3951516
2245	3.3512163	2305	3.3626709	2365	3.3738311	2425	3.3847117	2485	3.3953264
2246	3.3514097	2306	3.3628593	2366	3.3740147	2426	3.3848908	2486	3.3955011
2247	3.3516031	2307	3.3630476	2367	3.3741982	2427	3.3850698	2487	3.3956758
2248	3.3517963	2308	3.3632358	2368	3.3743817	2428	3.3852487	2488	3.3958504
2249	3.3519894	2309	3.3634239	2369	3.3745651	2429	3.3854275	2489	3.3960249
2250	3.3521825	2310	3.3636120	2370	3.3747483	2430	3.3856063	2490	3.3961993
2251	3.3523755	2311	3.3637999	2371	3.3749315	2431	3.3857849	2491	3.3963737
2252	3.3525684	2312	3.3639878	2372	3.3751147	2432	3.3859636	2492	3.3965480
2253	3.3527612	2313	3.3641756	2373	3.3752977	2433	3.3861421	2493	3.3967223
2254	3.3529539	2314	3.3643633	2374	3.3754807	2434	3.3863206	2494	3.3968964
2255	3.3531465	2315	3.3645510	2375	3.3756636	2435	3.3864950	2495	3.3970705
2256	3.3533391	2316	3.3647385	2376	3.3758464	2436	3.3866773	2496	3.3972446
2257	3.3535315	2317	3.3649260	2377	3.3760292	2437	3.3868555	2497	3.3974185
2258	3.3537239	2318	3.3651134	2378	3.3762118	2438	3.3870337	2498	3 3975924
2259	3.3539162	2319	3.3653007	2379	3.3763944	2439	3.3872118	2499	3.3977662
2260	3.3541084	2320	3.3654880	2380	3.3765769	2440	3.3873898	2500	3.3979400

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
2501	3.3981137	2561	3.4084096	2621	3.4184670	2681	3.4282953	2741	3.4379090
2502	3.3982873	2562	3.4085791	2622	3.4186327	2682	3.4284588	2742	3.4380674
2503	3.3984608	2563	3.4087486	2623	3.4187983	2683	3.4286207	2743	3.4382258
2504	3.3986343	2564	3.4089180	2624	3.4189638	2684	3.4287825	2744	3.4383841
2505	3.3988077	2565	3.4090874	2625	3.4191293	2685	3.4289443	2745	3.4385423
2506	3.3989811	2566	3.4092566	2626	3.4192947	2686	3.4291060	2746	3.4387005
2507	3.3991543	2567	3.4094259	2627	3.4194601	2687	3.4292677	2747	3.4388586
2508	3.3993275	2568	3.4095950	2628	3.4196254	2688	3.4294293	2748	3.4390167
2509	3.3995007	2569	3.4097641	2629	3.4197906	2689	3.4295908	2749	3.4391747
2510	3.3996737	2570	3.4099331	2630	3.4199557	2690	3.4297523	2750	3.4393327
2511	3.3998467	2571	3.4101021	2631	3.4201208	2691	3.4299137	2751	3.4394906
2512	3.4000196	2572	3.4102710	2632	3.4202859	2692	3.4300750	2752	3.4396484
2513	3.4001925	2573	3.4104393	2633	3.4204508	2693	3.4302363	2753	3.4398062
2514	3.4003653	2574	3.4106085	2634	3.4206158	2694	3.4303976	2754	3.4399639
2515	3.4005380	2575	3.4107772	2635	3.4207806	2695	3.4305588	2755	3.4401216
2516	3.4007105	2576	3.4109458	2636	3.4209454	2696	3.4307199	2756	3.4402792
2517	3.4008832	2577	3.4111144	2637	3.4211101	2697	3.4308809	2757	3.4404368
2518	3.4010557	2578	3.4112829	2638	3.4212748	2698	3.4310419	2758	3.4405943
2519	3.4012282	2579	3.4114513	2639	3.4214394	2699	3.4312029	2759	3.4407517
2520	3.4014005	2580	3.4116197	2640	3.4216039	2700	3.4313638	2760	3.4409091
2521	3.4015728	2581	3.4117880	2641	3.4217684	2701	3.4315246	2761	3.4410664
2522	3.4017451	2582	3.4119562	2642	3.4219328	2702	3.4316853	2762	3.4412237
2523	3.4019172	2583	3.4121244	2643	3.4220972	2703	3.4318460	2763	3.4413809
2524	3.4020893	2584	3.4122925	2644	3.4222614	2704	3.4320067	2764	3.4415380
2525	3.4022514	2585	3.4124605	2645	3.4224257	2705	3.4321673	2765	3.4416951
2526	3.4024333	2586	3.4126285	2646	3.4225898	2706	3.4323278	2766	3.4418522
2527	3.4026052	2587	3.4127964	2647	3.4227539	2707	3.4324882	2767	3.4420091
2528	3.4027771	2588	3.4129643	2648	3.4229180	2708	3.4326487	2768	3.4421661
2529	3.4029488	2589	3.4131320	2649	3.4230819	2709	3.4328090	2769	3.4423229
2530	3.4031205	2590	3.4132998	2650	3.4232459	2710	3.4329693	2770	3.4424798
2531	3.4032921	2591	3.4134674	2651	3.4234097	2711	3.4331295	2771	3.4426365
2532	3.4034637	2592	3.4136350	2652	3.4235735	2712	3.4332897	2772	3.4427932
2533	3.4036352	2593	3.4138025	2653	3.4237372	2713	3.4334498	2773	3.4429499
2534	3.4038076	2594	3.4139700	2654	3.4239009	2714	3.4336098	2774	3.4431064
2535	3.4039780	2595	3.4141374	2655	3.4240645	2715	3.4337698	2775	3.4432630
2536	3.4041492	2596	3.4143047	2656	3.4242281	1716	3.4339298	2776	3.4434195
2537	3.4043205	2597	3.4144719	2657	3.4243915	2717	3.4340896	2777	3.4435759
2538	3.4044916	2598	3.4146391	2658	3.4245550	2718	3.4342494	2778	3.4437322
2539	3.4046627	2599	3.4148063	2659	3.4247183	2719	3.4344092	2779	3.4438885
2540	3.4048337	2600	3.4149733	2660	3.4248816	2720	3.4345689	2780	3.4440448
2541	3.4050047	2601	3.4151403	2661	3.4250449	2721	3.4347285	2781	3.4442010
2542	3.4051755	2602	3.4153073	2662	3.4252080	2722	3.4348881	2782	3.4443571
2543	3.4053464	2603	3.4154742	2663	3.4253712	2723	3.4350476	2783	3.4445132
2544	3.4055161	2604	3.4156410	2664	3.4255342	2724	3.4352071	2784	3.4446692
2545	3.4056878	2605	2.4158077	2665	3.4256972	2725	3.4353675	2785	3.4448252
2546	3.4058584	2606	3.4159744	2666	3.4258601	2726	3.4355258	2786	3.4449811
2547	3.4060289	2607	3.4161410	2667	3.4260230	2727	3.4356851	2787	3.4451370
2548	3.4061994	2608	3.4163076	2668	3.4261858	2728	3.4358444	2788	3.4452928
2549	3.4063698	2609	3.4164741	2669	3.4263486	2729	3.4360035	2789	3.4454485
2550	3.4065402	2610	3.4166405	2670	3.4265113	2730	3.4361626	2790	3.4456042
2551	3.4067104	2611	3.4168069	2671	3.4266739	2731	3.4363217	2791	3.4457598
2552	3.4068807	2612	3.4169732	2672	3.4268364	2732	3.4364807	2792	3.4459154
2553	3.4070508	2613	3.4171394	2673	3.4269989	2733	3.4366396	2793	3.4460709
2554	3.4072209	2614	3.4173056	2674	3.4271614	2734	3.4367985	2794	3.4462264
2555	3.4073909	2615	3.4174717	2675	3.4273238	2735	3.4369573	2795	3.4463818
2556	3.4075608	2616	3.4176377	2676	3.4274861	2736	3.4371161	2796	3.4465372
2557	3.4077307	2617	3.4178037	2677	3.4276484	2737	3.4372748	2797	3.4466925
2558	3.4079005	2618	3.4179696	2678	3.4278106	2738	3.4374334	2798	3.4468477
2559	3.4080703	2619	3.4181355	2679	3.4279727	2739	3.4375920	2799	3.4470029
2560	3.4082400	2620	3.4183013	2680	3.4281348	2740	3.4377506	2800	3.4471580

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
2801	3.4473131	2861	3.4565178	2921	3.4655315	2981	3.4743620	3041	3.4830164
2802	3.4474681	2862	3.4566696	2922	3.4656802	2982	3.4745077	3042	3.4831592
2803	3.4476231	2863	3.4568213	2923	3.4658288	2983	3.4746532	3043	3.4833019
2804	3.4477780	2864	3.4569730	2924	3.4659774	2984	3.4747988	3044	3.4834446
2805	3.4479329	2865	3.4571246	2925	3.4661259	2985	3.4749443	3045	3.4835873
2806	3.4480877	2866	3.4572762	2926	3.4662743	2986	3.4750898	3046	3.4837299
2807	3.4482424	2867	3.4574277	2927	3.4664227	2987	3.4752352	3047	3.4838724
2808	3.4483971	2868	3.4575791	2928	3.4665711	2988	3.4753806	3048	3.4840150
2809	3.4485517	2869	3.4577305	2929	3.4667194	2989	3.4755259	3049	3.4841574
2810	3.4487063	2870	3.4578819	2930	3.4668676	2990	3.4756712	3050	3.4842998
2811	3.4488608	2871	3.4580332	2931	3.4670158	2991	3.4758164	3051	3.4844422
2812	3.4490153	2872	3.4581844	2932	3.4671640	2992	3.4759616	3052	3.4845845
2813	3.4491697	2873	3.4583356	2933	3.4673121	2993	3.4761067	3053	3.4847268
2814	3.4493241	2874	3.4584868	2934	3.4674601	2994	3.4762518	3054	3.4848690
2815	3.4494784	2875	3.4586378	2935	3.4676081	2995	3.4763968	3055	3.4850112
2816	3.4496326	2876	3.4587889	2936	3.4677560	2996	3.4765418	3056	3.4851533
2817	3.4497868	2877	3.4589399	2937	3.4679039	2997	3.4766867	3057	3.4852954
2818	3.4499410	2878	3.4590908	2938	3.4680518	2998	3.4768316	3058	3.4854375
2819	3.4500951	2879	3.4592417	2939	3.4681996	2999	3.4769765	3059	3.4855794
2820	3.4502491	2880	3.4593925	2940	3.4683473	3000	3.4771212	3060	3.4857214
2821	3.4504031	2881	3.4595432	2941	3.4684950	3001	3.4772660	3061	3.4858633
2822	3.4505570	2882	3.4596940	2942	3.4686427	3002	3.4774107	3062	3.4860052
2823	3.4507109	2883	3.4598446	2943	3.4687903	3003	3.4775553	3063	3.4861470
2824	3.4508647	2884	3.4599952	2944	3.4689378	3004	3.4776999	3064	3.4862888
2825	3.4510184	2885	3.4601458	2945	3.4690853	3005	3.4778445	3065	3.4864305
2826	3.4511721	2886	3.4602963	2946	3.4692327	3006	3.4779890	3066	3.4865721
2827	3.4513258	2887	3.4604468	2947	3.4693801	3007	3.4781334	3067	3.4867138
2828	3.4514794	2888	3.4605972	2948	3.4695275	3008	3.4782778	3068	3.4868553
2829	3.4516329	2889	3.4607475	2949	3.4696748	3009	3.4784222	3069	3.4869969
2830	3.4517864	2890	3.4608978	2950	3.4698220	3010	3.4785665	3070	3.4871384
2831	3.4519399	2891	3.4610481	2951	3.4699692	3011	3.4787107	3071	3.4872798
2832	3.4520932	2892	3.4611983	2952	3.4701163	3012	3.4788550	3072	3.4874212
2833	3.4522466	2893	3.4613484	2953	3.4702634	3013	3.4789991	3073	3.4875626
2834	3.4523998	2894	3.4614985	2954	3.4704105	3014	3.4791432	3074	3.4877039
2835	3.4525531	2895	3.4616486	2955	3.4705575	3015	3.4792873	3075	3.4878451
2836	3.4527062	2896	3.4617985	2956	3.4707044	3016	3.4794313	3076	3.4879863
2837	3.4528593	2897	3.4619485	2957	3.4708513	3017	3.4795753	3077	3.4881275
2838	3.4530124	2898	3.4620984	2958	3.4709982	3018	3.4797192	3078	3.4882686
2839	3.4531654	2899	3.4622482	2959	3.4711450	3019	3.4798631	3079	3.4884097
2840	3.4533183	2900	3.4623980	2960	3.4712917	3020	3.4800069	3080	3.4885507
2841	3.4534712	2901	3.4625477	2961	3.4714384	3021	3.4801507	3081	3.4886917
2842	3.4536241	2902	3.4626974	2962	3.4715850	3022	3.4802945	3082	3.4888326
2843	3.4537768	2903	3.4628470	2963	3.4717316	3023	3.4804381	3083	3.4889735
2844	3.4539296	2904	3.4629966	2964	3.4718782	3024	3.4805818	3084	3.4891144
2845	3.4540823	2905	3.4631461	2965	3.4720247	3025	3.4807254	3085	3.4892551
2846	3.4542349	2906	3.4632956	2966	3.4721711	3026	3.4808689	3086	3.4893959
2847	3.4543875	2907	3.4634450	2967	3.4723175	3027	3.4810124	3087	3.4895366
2848	3.4545400	2908	3.4635944	2968	3.4724639	3028	3.4811559	3088	3.4896773
2849	3.4546924	2909	3.4637437	2969	3.4726102	3029	3.4812993	3089	3.4898179
2850	3.4548449	2910	3.4638930	2970	3.4727564	3030	3.4814426	3090	3.4899585
2851	3.4549972	2911	3.4640422	2971	3.4729026	3031	3.4815859	3091	3.4900990
2852	3.4551495	2912	3.4641914	2972	3.4730488	3032	3.4817292	3092	3.4902395
2853	3.4553018	2913	3.4643405	2973	3.4731949	3033	3.4818724	3093	3.4903799
2854	3.4554540	2914	3.4644895	2974	3.4733410	3034	3.4820156	3094	3.4905203
2855	3.4556061	2915	3.4646385	2975	3.4734870	3035	3.4821587	3095	3.4906606
2856	3.4557582	2916	3.4647875	2976	3.4736329	3036	3.4823018	3096	3.4908009
2857	3.4559102	2917	3.4649364	2977	3.4737788	3037	3.4824448	3097	3.4909412
2858	3.4560622	2918	3.4650853	2978	3.4739247	3038	3.4825878	3098	3.4910814
2859	3.4562141	2919	3.4652341	2979	3.4740705	3039	3.4827307	3099	3.4912216
2860	3.4563660	2920	3.4653828	2980	3.4742163	3040	3.4828736	3100	3.4913617

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
3101	3.4915018	3161	3.4998245	3221	3.5079907	3281	3.5160062	3341	3.5238765
3102	3.4916418	3162	3.4999619	3222	3.5081255	3282	3.5161386	3342	3.5240064
3103	3.4917818	3163	3.5000992	3223	3.5082603	3283	3.5162709	3343	3.5241364
3104	3.4919217	3164	3.5002365	3224	3.5083950	3284	3.5164031	3344	3.5242663
3105	3.4920616	3165	3.5003737	3225	3.5085297	3285	3.5165354	3345	3.5243961
3106	3.4922014	3166	3.5005109	3226	3.5086644	3286	3.5166675	3346	3.5245259
3107	3.4923412	3167	3.5006481	3227	3.5087990	3287	3.5167997	3347	3.5246557
3108	3.4924810	3168	3.5007852	3228	3.5089335	3288	3.5169318	3348	3.5247854
3109	3.4926207	3169	3.5009222	3229	3.5090680	3289	3.5170639	3349	3.5249151
3110	3.4927604	3170	3.5010593	3230	3.5092025	3290	3.5171959	3350	3.5250448
3111	3.4929000	3171	3.5011962	3231	3.5093369	3291	3.5173279	3351	3.5251744
3112	3.4930396	3172	3.5013332	3232	3.5094713	3292	3.5174598	3352	3.5253040
3113	3.4931791	3173	3.5014701	3233	3.5096057	3293	3.5175917	3353	3.5254335
3114	3.4933186	3174	3.5016069	3234	3.5097400	3294	3.5177236	3354	3.5255630
3115	3.4934580	3175	3.5017437	3235	3.5098743	3295	3.5178554	3355	3.5256925
3116	3.4935974	3176	3.5018805	3236	3.5100085	3296	3.5179872	3356	3.5258219
3117	3.4937368	3177	3.5020172	3237	3.5101427	3297	3.5181189	3357	3.5259513
3118	3.4938761	3178	3.5021539	3238	3.5102768	3298	3.5182506	3358	3.5260807
3119	3.4940154	3179	3.5022905	3239	3.5104109	3299	3.5183823	3359	3.5262100
3120	3.4941546	3180	3.5024271	3240	3.5105450	3300	3.5185139	3360	3.5263393
3121	3.4942938	3181	3.5025637	3241	3.5106790	3301	3.5186455	3361	3.5264685
3122	3.4944329	3182	3.5027002	3242	3.5108130	3302	3.5187770	3362	3.5265977
3123	3.4945720	3183	3.5028366	3243	3.5109469	3303	3.5189085	3363	3.5267269
3124	3.4947110	3184	3.5029730	3244	3.5110808	3304	3.5190400	3364	3.5268560
3125	3.4948500	3185	3.5031094	3245	3.5112147	3305	3.5191715	3365	3.5269851
3126	3.4949890	3186	3.5032458	3246	3.5113485	3306	3.5193028	3366	3.5271141
3127	3.4951279	3187	3.5033821	3247	3.5114823	3307	3.5194342	3367	3.5272431
3128	3.4952667	3188	3.5035183	3248	3.5116160	3308	3.5195655	3368	3.5273721
3129	3.4954056	3189	3.5036545	3249	3.5117497	3309	3.5196968	3369	3.5275010
3130	3.4955443	3190	3.5037907	3250	3.5118834	3310	3.5198280	3370	3.5276299
3131	3.4956831	3191	3.5039268	3251	3.5120170	3311	3.5199592	3371	3.5277587
3132	3.4958217	3192	3.5040629	3252	3.5121505	3312	3.5200903	3372	3.5278876
3133	3.4959604	3193	3.5041989	3253	3.5122841	3313	3.5202214	3373	3.5280163
3134	3.4960990	3194	3.5043349	3254	3.5124175	3314	3.5203525	3374	3.5281451
3135	3.4962375	3195	3.5044709	3255	3.5125510	3315	3.5204835	3375	3.5282738
3136	3.4963760	3196	3.5046068	3256	3.5126844	3316	3.5206145	3376	3.5284024
3137	3.4965145	3197	3.5047426	3257	3.5128177	3317	3.5207455	3377	3.5285311
3138	3.4966529	3198	3.5048784	3258	3.5129511	3318	3.5208764	3378	3.5286596
3139	3.4967913	3199	3.5050142	3259	3.5130844	3319	3.5210072	3379	3.5287882
3140	3.4969296	3200	3.5051500	3260	3.5132176	3320	3.5211381	3380	3.5289167
3141	3.4970679	3201	3.5052857	3261	3.5133508	3321	3.5212689	3381	3.5290452
3142	3.4972062	3202	3.5054213	3262	3.5134839	3322	3.5213996	3382	3.5291736
3143	3.4973444	3203	3.5055569	3263	3.5136171	3323	3.5215303	3383	3.5293020
3144	3.4974825	3204	3.5056925	3264	3.5137501	3324	3.5216610	3384	3.5294303
3145	3.4976206	3205	3.5058280	3265	3.5138832	3325	3.5217916	3385	3.5295587
3146	3.4977587	3206	3.5059635	3266	3.5140162	3326	3.5219222	3386	3.5296869
3147	3.4978967	3207	3.5060989	3267	3.5141491	3327	3.5220528	3387	3.5298152
3148	3.4980347	3208	3.5062343	3268	3.5142820	3328	3.5221833	3388	3.5299434
3149	3.4981727	3209	3.5063697	3269	3.5144149	3329	3.5223128	3389	3.5300716
3150	3.4983105	3210	3.5065050	3270	3.5145477	3330	3.5224442	3390	3.5301997
3151	3.4984484	3211	3.5066403	3271	3.5146805	3331	3.5225746	3391	3.5303278
3152	3.4985862	3212	3.5067755	3272	3.5148133	3332	3.5227050	3392	3.5304558
3153	3.4987240	3213	3.5069107	3273	3.5149460	3333	3.5228353	3393	3.5305838
3154	3.4988617	3214	3.5070459	3274	3.5150787	3334	3.5229656	3394	3.5307118
3155	3.4989994	3215	3.5071810	3275	3.5152113	3335	3.5230958	3395	3.5308398
3156	3.4991370	3216	3.5073160	3276	3.5153439	3336	3.5232260	3396	3.5309677
3157	3.4992746	3217	3.5074511	3277	3.5154764	3337	3.5233562	3397	3.5310955
3158	3.4994121	3218	3.5075860	3278	3.5156089	3338	3.5234863	3398	3.5312234
3159	3.4995496	3219	3.5077210	3279	3.5157414	3339	3.5236164	3399	3.5313512
3160	3.4996871	3220	3.5078559	3280	3.5158738	3340	3.5237465	3400	3.5314789

CHILIAS IV.

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
3401	3.5316066	3461	3.5392016	3521	3.5466660	3581	3.5540043	3641	3.5512207
3402	3.5317343	3462	3.5393271	3522	3.5467893	3582	3.5541256	3642	3.5613399
3403	3.5318619	3463	3.5394525	3523	3.5469126	3583	3.5542468	3643	3.5614592
3404	3.5319895	3464	3.5395779	3524	3.5470359	3584	3.5543680	3644	3.5615784
3405	3.5321171	3465	3.5397032	3525	3.5471591	3585	3.5544891	3645	3.5616975
3406	3.5322446	3466	3.5398285	3526	3.5472823	3586	3.5546103	3646	3.5618167
3407	3.5323721	3467	3.5399538	3527	3.5474054	3587	3.5547314	3647	3.5619358
3408	3.5324995	3468	3.5400791	3528	3.5475286	3588	3.5548524	3648	3.5620548
3409	3.5326270	3469	3.5402043	3529	3.5476516	3589	3.5549734	3649	3.5621739
3410	3.5327544	3470	3.5403295	3530	3.5477747	3590	3.5550944	3650	3.5622929
3411	3.5328817	3471	3.5404546	3531	3.5478977	3591	3.5552154	3651	3.5624118
3412	3.5330090	3472	3.5405797	3532	3.5480207	3592	3.5553363	3652	3.5625308
3413	3.5331363	3473	3.5407048	3533	3.5481436	3593	3.5554572	3653	3.5626497
3414	3.5332635	3474	3.5408298	3534	3.5482665	3594	3.5555781	3654	3.5627685
3415	3.5333907	3475	3.5409548	3535	3.5483894	3595	3.5556989	3655	3.5628874
3416	3.5335179	3476	3.5410798	3536	3.5485122	3596	3.5558197	3656	3.5630062
3417	3.5336450	3477	3.5412047	3537	3.5486350	3597	3.5559404	3657	3.5631250
3418	3.5337720	3478	3.5413296	3538	3.5487578	3598	3.5560611	3658	3.5632437
3419	3.5338991	3479	3.5414544	3539	3.5488806	3599	3.5561818	3659	3.5633624
3420	3.5340261	3480	3.5415792	3540	3.5490033	3600	3.5563025	3660	3.5634811
3421	3.5341531	3481	3.5417040	3541	3.5491259	3601	3.5564231	3661	3.5635997
3422	3.5342800	3482	3.5418288	3542	3.5492485	3602	3.5565437	3662	3.5937183
3423	3.5344069	3483	3.5419535	3543	3.5493711	3603	3.5566643	3663	3.5638369
3424	3.5345337	3484	3.5420781	3544	3.5494937	3604	3.5567848	3664	3.5639555
3425	3.5346606	3485	3.5422028	3545	3.5496162	3605	3.5569053	3665	3.5640740
3426	3.5347873	3486	3.5423274	3546	3.5497387	3606	3.5570257	3666	3.5641925
3427	3.5349141	3487	3.5424519	3547	3.5498612	3607	3.5571461	3667	3.5643109
3428	3.5350408	3488	3.5425765	3548	3.5499836	3608	3.5572665	3668	3.5644293
3429	3.5351675	3489	3.5427010	3549	3.5501060	3609	3.5573869	3669	3.5645477
3430	3.5352941	3490	3.5428254	3550	3.5502283	3610	3.5575072	3670	3.5646661
3431	3.5354207	3491	3.5429498	3551	3.5503507	3611	3.5576275	3671	3.5647844
3432	3.5355473	3492	3.5430742	3552	3.5504729	3612	3.5577477	3672	3.5649027
3433	3.5356738	3493	3.5431986	3553	3.5505952	3613	3.5578680	3673	3.5650209
3434	3.5358003	3494	3.5433229	3554	3.5507174	3614	3.5579881	3674	3.5651391
3435	3.5359267	3495	3.5434472	3555	3.5508396	3615	3.5581083	3675	3.5652573
3436	3.5360531	3496	3.5435714	3556	3.5509617	3616	3.5582284	3676	3.5653755
3437	3.5361795	3497	3.5436956	3557	3.5510839	3617	3.5583485	3677	3.5654936
3438	3.5363059	3498	3.5438198	3558	3.5512059	3618	3.5584686	3678	3.5656117
3439	3.5364322	3499	3.5439439	3559	3.5513280	3619	3.5585886	3679	3.5657298
3440	3.5365584	3500	3.5440680	3560	3.5514500	3620	3.5587086	3680	3.5658478
3441	3.5366847	3501	3.5441921	3561	3.5515720	3621	3.5588285	3681	3.5659658
3442	3.5368109	3502	3.5443161	3562	3.5516939	3622	3.5589484	3682	3.5660838
3443	3.5369370	3503	3.5444401	3563	3.5518158	3623	3.5590683	3683	3.5662017
3444	3.5370631	3504	3.5445641	3564	3.5519377	3624	3.5591881	3684	3.5663196
3445	3.5371892	3505	3.5446880	3565	3.5520595	3625	3.5593080	3685	3.5664375
3446	3.5373153	3506	3.5448119	3566	3.5521813	3626	3.5594278	3686	3.5665553
3447	3.5374413	3507	3.5449358	3567	3.5523031	3627	3.5595475	3687	3.5666731
3448	3.5375672	3508	3.5450596	3568	3.5524248	3628	3.5596673	3688	3.5667909
3449	3.5376932	3509	3.5451834	3569	3.5525465	3629	3.5597870	3689	3.5669086
3450	3.5378191	3510	3.5453071	3570	3.5526682	3630	3.5599066	3690	3.5670264
3451	3.5379449	3511	3.5454308	3571	3.5527898	3631	3.5600262	3691	3.5671440
3452	3.5380708	3512	3.5455545	3572	3.5529114	3632	3.5601458	3692	3.5672617
3453	3.5381966	3513	3.5456781	3573	3.5530330	3633	3.5602654	3693	3.5673793
3454	3.5383223	3514	3.5458017	3574	3.5531545	3634	3.5603849	3694	3.5674969
3455	3.5384480	3515	3.5459253	3575	3.5532760	3635	3.5605044	3695	3.5676144
3456	3.5385737	3516	3.5460489	3576	3.5533975	3636	3.5606239	3696	3.5677320
3457	3.5386994	3517	3.5461724	3577	3.5535189	3637	3.5607433	3697	3.5678494
3458	3.5388250	3518	3.5462958	3578	3.5536403	3638	3.5608627	3698	3.5679669
3459	3.5389506	3519	3.5464193	3579	3.5537617	3639	3.5609820	3699	3.5680843
3460	3.5390761	3520	3.5465427	3580	3.5538830	3640	3.5611014	3700	3.5682017

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
3701	3.5683191	3761	3.5753033	3821	3.5821770	3881	3.5889436	3941	3.5956064
3702	3.5684364	3762	3.5754188	3822	3.5822907	3882	3.5890555	3942	3.5957165
3703	3.5685537	3763	3.5755342	3823	3.5824043	3883	3.5891674	3943	3.5958268
3704	3.5686710	3764	3.5756496	3824	3.5825179	3884	3.5892792	3944	3.5959369
3705	3.5687882	3765	3.5757650	3825	3.5826314	3885	3.5893910	3945	3.5960470
3706	3.5689054	3766	3.5758803	3826	3.5827450	3886	3.5895028	3946	3.5961571
3707	3.5690226	3767	3.5759956	3827	3.5828585	3887	3.5896145	3947	3.5962671
3708	3.5691397	3768	3.5761109	3828	3.5829719	3888	3.5897262	3948	3.5963771
3709	3.5692568	3769	3.5762261	3829	3.5830854	3889	3.5898379	3949	3.5964871
3710	3.5693739	3770	3.5753413	3830	3.5831988	3890	3.5899496	3950	3.5965971
3711	3.5694909	3771	3.5764565	3831	3.5833121	3891	3.5900612	3951	3.5967070
3712	3.5696080	3772	3.5765717	3832	3.5834255	3892	3.5901728	3952	3.5968169
3713	3.5697249	3773	3.5766868	3833	3.5835388	3893	3.5902844	3953	3.5969268
3714	3.5698419	3774	3.5768019	3834	3.5836521	3894	3.5903959	3954	3.5970367
3715	3.5699588	3775	3.5769169	3835	3.5837654	3895	3.5905075	3955	3.5971465
3716	3.5700757	3776	3.5770320	3836	3.5838786	3896	3.5906189	3956	3.5972563
3717	3.5701926	3777	3.5771470	3837	3.5839918	3897	3.5907304	3957	3.5973660
3718	3.5703094	3778	3.5772619	3838	3.5841050	3898	3.5908418	3958	3.5974758
3719	3.5704262	3779	3.5773769	3839	3.5842181	3899	3.5909532	3959	3.5975855
3720	3.5705429	3780	3.5774918	3840	3.5843312	3900	3.5910646	3960	3.5976952
3721	3.5706597	3781	3.5776067	3841	3.5844443	3901	3.5911759	3961	3.5978048
3722	3.5707764	3782	3.5777215	3842	3.5845574	3902	3.5912873	3962	3.5979145
3723	3.5708930	3783	3.5778363	3843	3.5846704	3903	3.5913985	3963	3.5980241
3724	3.5710097	3784	3.5779511	3844	3.5847834	3904	3.5915098	3964	3.5981336
3725	3.5711263	3785	3.5780659	3845	3.5848963	3905	3.5916210	3965	3.5982432
3726	3.5712428	3786	3.5781806	3846	3.5850093	3906	3.5917322	3966	3.5983527
3727	3.5713594	3787	3.5782953	3847	3.5851222	3907	3.5918434	3967	3.5984622
3728	3.5714759	3788	3.5784100	3848	3.5852351	3908	3.5919545	3968	3.5985717
3729	3.5715924	3789	3.5785246	3849	3.5853479	3909	3.5920657	3969	3.5986811
3730	3.5717088	3790	3.5786392	3850	3.5854607	3910	3.5921767	3970	3.5987905
3731	3.5718252	3791	3.5787538	3851	3.5855735	3911	3.5922878	3971	3.5988999
3732	3.5719416	3792	3.5788683	3852	3.5856863	3912	3.5923988	3972	3.5990092
3733	3.5720580	3793	3.5789828	3853	3.5857990	3913	3.5925098	3973	3.5991186
3734	3.5721743	3794	3.5790973	3854	3.5859117	3914	3.5926208	3974	3.5992279
3735	3.5722906	3795	3.5792118	3855	3.5860244	3915	3.5927318	3975	3.5993371
3736	3.5724069	3796	3.5793262	3856	3.5861370	3916	3.5928427	3976	3.5994464
3737	3.5725231	3797	3.5794406	3857	3.5862496	3917	3.5929536	3977	3.5995556
3738	3.5726393	3798	3.5795550	3858	3.5863622	3918	3.5930644	3978	3.5996648
3739	3.5727555	3799	3.5796693	3859	3.5864748	3919	3.5931753	3979	3.5997739
3740	3.5728716	3800	3.5797836	3860	3.5865873	3920	3.5932861	3980	3.5998831
3741	3.5729877	3801	3.5798979	3861	3.5866998	3921	3.5933968	3981	3.5999922
3742	3.5731038	3802	3.5800121	3862	3.5868123	3922	3.5935076	3982	3.6001012
3743	3.5732198	3803	3.5801263	3863	3.5869247	3923	3.5936183	3983	3.6002103
3744	3.5733358	3804	3.5802405	3864	3.5870371	3924	3.5937290	3984	3.6003193
3745	3.5734518	3805	3.5803547	3865	3.5871495	3925	3.5938397	3985	3.6004283
3746	3.5735678	3806	3.5804688	3866	3.5872618	3926	3.5939503	3986	3.6005373
3747	3.5736837	3807	3.5805829	3867	3.5873742	3927	3.5940609	3987	3.6006462
3748	3.5737996	3808	3.5806969	3868	3.5874865	3928	3.5941715	3988	3.6007551
3749	3.5739154	3809	3.5808110	3869	3.5875987	3929	3.5942820	3989	3.6008640
3750	3.5740313	3810	3.5809260	3870	3.5877110	3930	3.5943925	3990	3.6009729
3751	3.5741471	3811	3.5810389	3871	3.5878232	3931	3.5945030	3991	3.6010817
3752	3.5742628	3812	3.5811529	3872	3.5879353	3932	3.5946135	3992	3.6011905
3753	3.5743786	3813	3.5812668	3873	3.5880475	3933	3.5947239	3993	3.6012993
3754	3.5744943	3814	3.5813807	3874	3.5881596	3934	3.5948343	3994	3.6014081
3755	3.5746099	3815	3.5814945	3875	3.5882717	3935	3.5949447	3995	3.6015168
3756	3.5747256	3816	3.5816084	3876	3.5883838	3936	3.5950551	3996	3.6016255
3757	3.5748412	3817	3.5817221	3877	3.5884958	3937	3.5951654	3997	3.6017341
3758	3.5749568	3818	3.5818359	3878	3.5886058	3938	3.5952757	3998	3.6018428
3759	3.5750723	3819	3.5819496	3879	3.5887198	3939	3.5953860	3999	3.6019514
3760	3.5751878	3820	3.5820634	3880	3.5888317	3940	3.5954962	4000	3.6020600

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
4001	3.6021685	4061	3.6086330	4121	3.6150026	4181	3.6212802	4241	3.6274683
4002	3.6022771	4062	3.6087399	4122	3.6151080	4182	3.6213840	4242	3.6275707
4003	3.6023855	4063	3.6088468	4123	3.6152133	4183	3.6214879	4243	3.6276730
4004	3.6024941	4064	3.6089537	4124	3.6153186	4184	3.6215917	4244	3.6277754
4005	3.6026025	4065	3.6090605	4125	3.6154239	4185	3.6216955	4245	3.6278777
4006	3.6027109	4066	3.6091674	4126	3.6155292	4186	3.6217992	4246	3.6279800
4007	3.6028193	4067	3.6092742	4127	3.6156345	4187	3.6219030	4247	3.6280823
4008	3.6029277	4068	3.6093809	4128	3.6157397	4188	3.6220067	4248	3.6281845
4009	3.6030360	4069	3.6094877	4129	3.6158449	4189	3.6221104	4249	3.6282867
4010	3.6031444	4070	3.6095944	4130	3.6159500	4190	3.6222140	4250	3.6283889
4011	3.6032527	4071	3.6097011	4131	3.6160552	4191	3.6223177	4251	3.6284911
4012	3.6033609	4072	3.6098078	4132	3.6161603	4192	3.6224213	4252	3.6285932
4013	3.6034691	4073	3.6099144	4133	3.6162654	4193	3.6225249	4253	3.6286954
4014	3.6035774	4074	3.6100210	4134	3.6163705	4194	3.6226284	4254	3.6287975
4015	3.6036855	4075	3.6101276	4135	3.6164755	4195	3.6227320	4255	3.6288996
4016	3.6037937	4076	3.6102342	4136	3.6165805	4196	3.6228355	4256	3.6290016
4017	3.6039018	4077	3.6103407	4137	3.6166855	4197	3.6229390	4257	3.6291036
4018	3.6040099	4078	3.6104472	4138	3.6167905	4198	3.6230424	4258	3.6292056
4019	3.6041180	4079	3.6105537	4139	3.6168954	4199	3.6231459	4259	3.6293076
4020	3.6042260	4080	3.6106602	4140	3.6170003	4200	3.6232493	4260	3.6294096
4021	3.6043341	4081	3.6107666	4141	3.6171052	4201	3.6233527	4261	3.6295115
4022	3.6044421	4082	3.6108730	4142	3.6172101	4202	3.6234560	4262	3.6296134
4023	3.6045500	4083	3.6109794	4143	3.6173149	4203	3.6235594	4263	3.6297153
4024	3.6046580	4084	3.6110857	4144	3.6174197	4204	3.6236627	4264	3.6298172
4025	3.6047659	4085	3.6111921	4145	3.6175245	4205	3.6337660	4265	3.6299190
4026	3.6048738	4086	3.6112984	4146	3.6176293	4206	3.6238693	4266	3.6300208
4027	3.6049816	4087	3.6114046	4147	3.6177340	4207	3.6239725	4267	3.6301226
4028	3.6050895	4088	3.6115109	4148	3.6178387	4208	3.6240757	4268	3.6302244
4029	3.6051973	4089	3.6116171	4149	3.6179434	4209	3.6241789	4269	3.6303261
4030	3.6053050	4090	3.6117233	4150	3.6180481	4210	3.6242821	4270	3.6304279
4031	3.6054128	4091	3.6118295	4151	3.6181527	4211	3.6243852	4271	3.6305296
4032	3.6055205	4092	3.6119356	4152	3.6182573	4212	3.6244884	4272	3.6306312
4033	3.6056282	4093	3.6120417	4153	3.6183619	4213	3.6245914	4273	3.6307329
4034	3.6057359	4094	3.6121478	4154	3.6184665	4214	3.6246945	4274	3.6308345
4035	3.6058435	4095	3.6122539	4155	3.6185710	4215	3.6247976	4275	3.6309361
4036	3.6059511	4096	3.6123599	4156	3.6186755	4216	3.6249006	4276	3.6310377
4037	3.6060587	4097	3.6124660	4157	3.6187800	4217	3.6250036	4277	3.6311392
4038	3.6061663	4098	3.6125719	4158	3.6188845	4218	3.6251066	4278	3.6312408
4039	3.6062738	4099	3.6126779	4159	3.6189889	4219	3.6252095	4279	3.6313423
4040	3.6063814	4100	3.6127838	4160	3.6190933	4220	3.6253124	4280	3.6314438
4041	3.6064888	4101	3.6128898	4161	3.6191977	4221	3.6254153	4281	3.6315452
4042	3.6065963	4102	3.6129956	4162	3.6193021	4222	3.6255182	4282	3.6316467
4043	3.6067037	4103	3.6131015	4163	3.6194064	4223	3.6256211	4283	3.6317481
4044	3.6068111	4104	3.6132073	4164	3.6195107	4224	3.6257239	4284	3.6318495
4045	3.6069185	4105	3.6133132	4165	3.6196150	4225	3.6258267	4285	3.6319508
4046	3.6070259	4106	3.6134189	4166	3.6197193	4226	3.6259295	4286	3.6320522
4047	3.6071332	4107	3.6135247	4167	3.6198235	4227	3.6260322	4287	3.6321535
4048	3.6072405	4108	3.6136304	4168	3.6199277	4228	3.6261350	4288	3.6322548
4049	3.6073478	4109	3.6137361	4169	3.6200319	4229	3.6262377	4289	3.6323560
4050	3.6074550	4110	3.6138418	4170	3.6201360	4230	3.6263403	4290	3.6324573
4051	3.6075622	4111	3.6139475	4171	3.6202402	4231	3.6264430	4291	3.6325585
4052	3.6076694	4112	3.6140531	4172	3.6203443	4232	3.6265456	4292	3.6326597
4053	3.6077766	4113	3.6141587	4173	3.6204484	4233	3.6266483	4293	3.6327609
4054	3.6078837	4114	3.6142643	4174	3.6205524	4234	3.6267508	4294	3.6328620
4055	3.6079908	4115	3.6143698	4175	3.6206565	4235	3.6268534	4295	3.6329632
4056	3.6080979	4116	3.6144754	4176	3.6207605	4236	3.6269559	4296	3.6330643
4057	3.6082050	4117	3.6145809	4177	3.6208645	4237	3.6270585	4297	3.6331653
4058	3.6083120	4118	3.6146863	4178	3.6209684	4238	3.6271609	4298	3.6332664
4059	3.6084190	4119	3.6147918	4179	3.6210724	4239	3.6272634	4299	3.6333674
4060	3.6085260	4120	3.6148972	4180	3.6211763	4240	3.6273658	4300	3.6334684

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
4301	3.6335694	4361	3.6395861	4421	3.6455205	4481	3.6513749	4541	3.6571515
4302	3.6336704	4362	3.6396857	4422	3.6455187	4482	3.6514718	4542	3.6572471
4303	3.6337713	4363	3.6397852	4423	3.6457169	4483	3.6515687	4543	3.6573427
4304	3.6338723	4364	3.6398847	4424	3.6458151	4484	3.6516656	4544	3.6574383
4305	3.6339731	4365	3.6399842	4425	3.6459133	4485	3.6517624	4545	3.6575339
4306	3.6340740	4366	3.6400837	4426	3.6460114	4486	3.6518593	4546	3.6576294
4307	3.6341749	4367	3.6401832	4427	3.6461095	4487	3.6519561	4547	3.6577249
4308	3.6342757	4368	3.6402826	4428	3.6462076	4488	3.6520528	4548	3.6578204
4309	3.6343765	4369	3.6403820	4429	3.6463057	4489	3.6521496	4549	3.6579159
4310	3.6344773	4370	3.6404814	4430	3.6464037	4490	3.6522464	4550	3.6580114
4311	3.6345780	4371	3.6405808	4431	3.6465017	4491	3.6523430	4551	3.6581068
4312	3.6346787	4372	3.6408601	4432	3.6465997	4492	3.6524397	4552	3.6582022
4313	3.6347794	4373	3.6407795	4433	3.6466977	4493	3.6525364	4553	3.6582973
4314	3.6348801	4374	3.6408788	4434	3.6367957	4494	3.6526331	4554	3.6583930
4315	3.6349808	4375	3.6409780	4435	3.6468936	4495	3.6527297	4555	3.6584884
4316	3.6350814	4376	3.6410773	4436	3.6469915	4496	3.6528263	4556	3.6585837
4317	3.6351820	4377	3.6411765	4437	3.6470894	4497	3.6529229	4557	3.6586790
4318	3.6352826	4378	3.6412757	4438	3.6471873	4498	3.6530194	4558	3.6587743
4319	3.6353832	4379	3.6413749	4439	3.6472851	4499	3.6531160	4559	3.6588696
4320	3.6354837	4380	3.6414741	4440	3.6473830	4500	3.6532125	4560	3.6589648
4321	3.6355843	4381	3.6415732	4441	3.6474808	4501	3.6533090	4561	3.6590600
4322	3.6356848	4382	3.6416724	4442	3.6475785	4502	3.6534055	4562	3.6591553
4323	3.6357852	4383	3.6417715	4443	3.6476763	4503	3.6535019	4563	3.6592505
4324	3.6358857	4384	3.6418705	4444	3.6477740	4504	3.6535984	4564	3.6593456
4325	3.6359861	4385	3.6419696	4445	3.6478718	4505	3.6536948	4565	3.6594408
4326	3.6360865	4386	3.6420686	4446	3.6479694	4506	3.6537912	4566	3.6595359
4327	3.6361869	4387	3.6421676	4447	3.6480671	4507	3.6538875	4567	3.6596310
4328	3.6362872	4388	3.6422666	4448	3.6481648	4508	3.6539839	4568	3.6597261
4329	3.6363876	4389	3.6423656	4449	3.6482624	4509	3.6540802	4569	3.6598211
4330	3.6364879	4390	3.6424645	4450	3.6483600	4510	3.6541765	4570	3.6599162
4331	3.6365882	4391	3.6425634	4451	3.6484576	4511	3.6542728	4571	3.6600112
4332	3.6366884	4392	3.6426623	4452	3.6485551	4512	3.6543691	4572	3.6601062
4333	3.6367887	4393	3.6427612	4453	3.6486527	4513	3.6544653	4573	3.6602012
4334	3.6368889	4394	3.6428600	4454	3.6487502	4514	3.6545615	4574	3.6602962
4335	3.6369891	4395	3.6429589	4455	3.6488477	4515	3.6546577	4575	3.6603911
4336	3.6370893	4396	3.6430577	4456	3.6489452	4516	3.6547539	4576	3.6604860
4337	3.6371894	4397	3.6431565	4457	3.6490426	4517	3.6548501	4577	3.6605809
4338	3.6372895	4398	3.6432552	4458	3.6491401	4518	3.6549462	4578	3.6606758
4339	3.6373896	4399	3.6433540	4459	3.6492375	4519	3.6550423	4579	3.6607706
4340	3.6374897	4400	3.6434527	4460	3.6493348	4520	3.6551384	4580	3.6608655
4341	3.6375898	4401	3.6435514	4461	3.6494322	4521	3.6552345	4581	3.6609603
4342	3.6376898	4402	3.6436500	4462	3.6495296	4522	3.6553305	4582	3.6610551
4343	3.6377898	4403	3.6437487	4463	3.6496269	4523	3.6554266	4583	3.6611498
4344	3.6378898	4404	3.6438473	4464	3.6497242	4524	3.6555226	4584	3.6612446
4345	3.6379898	4405	3.6439459	4465	3.6498215	4525	3.6556186	4585	3.6613393
4346	3.6380897	4406	3.6440445	4466	3.6499187	4526	3.6557145	4586	3.6614340
4347	3.6381896	4407	3.6441430	4467	3.6500159	4527	3.6558105	4587	3.6615287
4348	3.6382895	4408	3.6442416	4468	3.6501131	4528	3.6559064	4588	3.6616234
4349	3.6383894	4409	3.6443401	4469	3.6502103	4529	3.6560023	4589	3.6617180
4350	3.6384892	4410	3.6444386	4470	3.6503075	4530	3.6560982	4590	3.6618127
4351	3.6385891	4411	3.6445370	4471	3.6504047	4531	3.6561941	4591	3.6619073
4352	3.6386889	4412	3.6446355	4472	3.6505018	4532	3.6562899	4592	3.6620019
4353	3.6387887	4413	3.6447339	4473	3.6505989	4533	3.6563857	4593	3.6620964
4354	3.6388884	4414	3.6448323	4474	3.6506960	4534	3.6564815	4594	3.6621910
4355	3.6389881	4415	3.6449307	4475	3.6507930	4535	3.6565773	4595	3.6622855
4356	3.6390879	4416	3.6450291	4476	3.6508901	4536	3.6566730	4596	3.6623800
4357	3.6391875	4417	3.6451274	4477	3.6509871	4537	3.6567688	4597	3.6624745
4358	3.6392872	4418	3.6452257	4478	3.6510841	4538	3.6568645	4598	3.6625690
4359	3.6393869	4419	3.6453240	4479	3.6511811	4539	3.6569602	4599	3.6626634
4360	3.6394865	4420	3.6454223	4480	3.6512780	4540	3.6570558	4600	3.6627578

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
4601	3.6628522	4661	3.6684791	4721	3.6740340	4781	3.6795187	4841	3.6849351
4602	3.6629466	4662	3.6685723	4722	3.6741260	4782	3.6796096	4842	3.6850248
4603	3.6630410	4663	3.6686654	4723	3.6742179	4783	3.6797004	4843	3.6851145
4604	3.6631353	4664	3.6687585	4724	3.6743099	4784	3.6797912	4844	3.6852041
4605	3.6632296	4665	3.6688516	4725	3.6744018	4785	3.6798819	4845	3.6852938
4606	3.6633239	4666	3.6689447	4726	3.6744937	4786	3.6799727	4846	3.6853834
4607	3.6634182	4667	3.6690378	4727	3.6745856	4787	3.6800634	4847	3.6854730
4608	3.6635125	4668	3.6691308	4728	3.6746775	4788	3.6801541	4848	3.6855626
4609	3.6636067	4669	3.6692239	4729	3.6747693	4789	3.6802448	4849	3.6856522
4610	3.6637009	4670	3.6693169	4730	3.6748611	4790	3.6803355	4850	3.6857417
4611	3.6637951	4671	3.6694099	4731	3.6749529	4791	3.6804262	4851	3.6858313
4612	3.6638893	4672	3.6695028	4732	3.6750447	4792	3.6805168	4852	3.6859208
4613	3.6639834	4673	3.6695958	4733	3.6751365	4793	3.6806074	4853	3.6860103
4614	3.6640476	4674	3.6696887	4734	3.6752282	4794	3.6806980	4854	3.6860998
4615	3.6641717	4675	3.6697816	4735	3.6753200	4795	3.6807886	4855	3.6861892
4616	3.6642658	4676	3.6698745	4736	3.6754117	4796	3.6808792	4856	3.6862787
4617	3.6643599	4677	3.6699674	4737	3.6755033	4797	3.6809697	4857	3.6863681
4618	3.6644539	4678	3.6700602	4738	3.6755950	4798	3.6810602	4858	3.6864575
4619	3.6645480	4379	3.6701530	4739	3.6756867	4799	3.6811507	4859	3.6865469
4620	3.6646420	4680	3.6702458	4740	3.6757783	4800	3.6812412	4860	3.6866363
4621	3.6647360	4681	3.6703386	4741	3.6758699	4801	3.6813317	4861	3.6867256
4622	3.6648299	4682	3.6704314	4742	3.6759615	4802	3.6814221	4862	3.6868149
4623	3.6649239	4683	3.6705241	4743	3.6760531	4803	3.6815126	4863	3.6869043
4624	3.6650178	4684	3.6706169	4744	3.6761447	4804	3.6816030	4864	3.6869936
4625	3.6651117	4685	3.6707096	4745	3.6762362	4805	3.6816934	4865	3.6870828
4626	3.6652056	4686	3.6708023	4746	3.6763277	4806	3.6817838	4866	3.6871721
4627	3.6652995	4687	3.6708949	4747	3.6764192	4807	3.6818741	4867	3.6872613
4628	3.6653933	4688	3.6709876	4748	3.6765107	4808	3.6819644	4868	3.6873506
4629	3.6654872	4689	3.6710802	4749	3.6766022	4809	3.6820548	4869	3.6874358
4630	3.6655810	4690	3.6711728	4750	3.6766936	4810	3.6821451	4870	3.6875290
4631	3.6656748	4691	3.6712654	4751	3.6767850	4811	3.6822353	4871	3.6876181
4632	3.6657685	4692	3.6713580	4752	3.6768764	4812	3.6823256	4872	3.6877073
4633	3.6658523	4693	3.6714505	4753	3.6769678	4813	3.6824159	4873	3.6877964
4634	3.6659560	4694	3.6715431	4754	3.6770592	4814	3.6825061	4874	3.6878855
4635	3.6660497	4695	3.6716356	4755	3.6771505	4815	3.6825963	4875	3.6879746
4636	3.6661434	4696	3.6717281	4756	3.6772418	4816	3.6826865	4876	3.6880637
4637	3.6662371	4697	3.6718206	4757	3.6773331	4817	3.6827766	4877	3.6881527
4638	3.6663307	4698	3.6719130	4758	3.6774244	4818	3.6828668	4878	3.6882418
4639	3.6664244	4699	3.6720054	4759	3.6775157	4819	3.6829569	4879	3.6883308
4640	3.6665180	4700	3.6720978	4760	3.6776069	4820	3.6830470	4880	3.6884198
4641	3.6666116	4701	3.6721902	4761	3.6776982	4821	3.6831371	4881	3.6885088
4642	3.6667051	4702	3.6722826	4762	3.6777894	4822	3.6832272	4882	3.6885978
4643	3.6667987	4703	3.6723750	4763	3.6778806	4823	3.6833173	4883	3.6886867
4644	3.6668922	4704	3.6724673	4764	3.6779717	4824	3.6834073	4884	3.6887756
4645	3.6669857	4705	3.6725596	4765	3.6780629	4825	3.6834973	4885	3.6888646
4646	3.6670792	4706	3.6726519	4766	3.6781540	4826	3.6835873	4886	3.6889535
4647	3.6671727	4707	3.6727442	4767	3.6782451	4827	3.6836773	4887	3.6890423
4648	3.6672661	4708	3.6728364	4768	3.6783362	4828	3.6837673	4888	3.6891312
4649	3.6673595	4709	3.6729287	4769	3.6784273	4829	3.6838572	4889	3.6892200
4650	3.6674529	4710	3.6730209	4770	3.6785184	4830	3.6839471	4890	3.6893088
4651	3.6675463	4711	3.6731131	4771	3.6786094	4831	3.6840370	4891	3.6893977
4652	3.6676397	4712	3.6732053	4772	3.6787004	4832	3.6841269	4892	3.6894864
4653	3.6677330	4713	3.6732974	4773	3.6787914	4833	3.6842168	4893	3.6895752
4654	3.6678264	4714	3.6733896	4774	3.6788824	4834	3.6843066	4894	3.6896640
4655	3.6679197	4715	3.6734817	4775	3.6789734	4835	3.6843965	4895	3.6897527
4656	3.6680130	4716	3.6735738	4776	3.6790643	4836	3.6844863	4896	3.6898414
4657	3.6681062	4717	3.6736659	4777	3.6791552	4837	3.6845761	4897	3.6899301
4658	3.6681995	4718	3.6737579	4778	3.6792461	4838	3.6846659	4898	3.6900188
4659	3.6682927	4719	3.6738500	4779	3.6793370	4839	3.6847556	4899	3.6901074
4660	3.6683859	4720	3.6739420	4780	3.6794279	4840	3.6848454	4900	3.6901961

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
4901	3.6902847	4961	3.6955692	5021	3.7007902	5081	3.7059492	5141	3.7110476
4902	3.6903733	4962	3.6956567	5022	3.7008767	5082	3.7060347	5142	3.7111321
4903	3.6904619	4963	3.6957443	5023	3.7009632	5083	3.7061201	5143	3.7112165
4904	3.6905505	4964	3.6958318	5024	3.7010496	5084	3.7062055	5144	3.7113009
4905	3.6906390	4965	3.6959192	5025	3.7011361	5085	3.7062909	5145	3.7113854
4906	3.6907295	4966	3.6960067	5026	3.7012225	5086	3.7063763	5146	3.7114698
4907	3.6908160	4967	3.6960942	5027	3.7013089	5087	3.7064617	5147	3.7115542
4908	3.6909045	4968	3.6961816	5028	3.7013953	5088	3.7065471	5148	3.7116385
4909	3.6909930	4969	3.6962690	5029	3.7014816	5089	3.7066324	5149	3.7117229
4910	3.6910815	4970	3.6963564	5030	3.7015680	5090	3.7067178	5150	3.7118072
4911	3.6911699	4971	3.6964438	5031	3.7016543	5091	3.7068031	5151	3.7118915
4912	3.6912583	4972	3.6965311	5032	3.7017406	5092	3.7068884	5152	3.7119758
4913	3.6913468	4973	3.6966184	5033	3.7018269	5093	3.7069737	5153	3.7120601
4914	3.6914351	4974	3.6967058	5034	3.7019132	5094	3.7070589	5154	3.7121444
4915	3.6915235	4975	3.6967931	5035	3.7019995	5095	3.7071442	5155	3.7122287
4916	3.6916119	4976	3.6968804	5036	3.7020857	5096	3.7072294	5156	3.7123129
4917	3.6917002	4977	3.6969676	5037	3.7021719	5097	3.7073146	5157	3.7123971
4918	3.6917885	4978	3.6970549	5038	3.7022582	5098	3.7073998	5158	3.7124813
4919	3.6918768	4979	3.6971421	5039	3.7023443	5099	3.7074850	5159	3.7125655
4920	3.6919651	4980	3.6972293	5040	3.7024305	5100	3.7075702	5160	3.7126497
4921	3.6920534	4981	3.6973165	5041	3.7025167	5101	3.7076553	5161	3.7127338
4922	3.6921416	4982	3.6974037	5042	3.7026028	5102	3.7077404	5162	3.7128180
4923	3.6922298	4983	3.6974909	5043	3.7026890	5103	3.7078256	5163	3.7129021
4924	3.6923180	4984	3.6975780	5044	3.7027751	5104	3.7079107	5164	3.7129862
4925	3.6924062	4985	3.6976652	5045	3.7028612	5105	3.7079957	5165	3.7130703
4926	3.6924944	4986	3.6977523	5046	3.7029472	5106	3.7080808	5166	3.7131544
4927	3.6925826	4987	3.6978394	5047	3.7030333	5107	3.7081658	5167	3.7132385
4928	3.6926707	4988	3.6979264	5048	3.7031193	5108	3.7082509	5168	3.7133225
4929	3.6927588	4989	3.6980135	5049	3.7032054	5109	3.7083359	5169	3.7134065
4930	3.6928469	4990	3.6981005	5050	3.7032914	5110	3.7084209	5170	3.7134905
4931	3.6929350	4991	3.6981876	5051	3.7033774	5111	3.7085059	5171	3.7135745
4932	3.6930231	4992	3.6982746	5052	3.7034633	5112	3.7085908	5172	3.7136585
4933	3.6931111	4993	3.6983616	5053	3.7035493	5113	3.7086758	5173	3.7137425
4934	3.6931991	4994	3.6984486	5054	3.7036352	5114	3.7087607	5174	3.7138264
4935	3.6932871	4995	3.6985355	5055	3.7037211	5115	3.7088456	5175	3.7139103
4936	3.6933751	4996	3.6986224	5056	3.7038071	5116	3.7089305	5176	3.7139943
4937	3.6934631	4997	3.6987093	5057	3.7038929	5117	3.7090154	5177	3.7140782
4938	3.6935511	4998	3.6987962	5058	3.7039788	5118	3.7091003	5178	3.7141620
4939	3.6936390	4999	3.6988831	5059	3.7040647	5119	3.7091851	5179	3.7142459
4940	3.6937269	5000	3.6989700	5060	3.7041505	5120	3.7092697	5180	3.7143297
4941	3.6938148	5001	3.6990568	5061	3.7042363	5121	3.7093548	5181	3.7144136
4942	3.6939027	5002	3.6991437	5062	3.7043221	5122	3.7094396	5182	3.7144974
4943	3.6939906	5003	3.6992305	5063	3.7044079	5123	3.7095243	5183	3.7145812
4944	3.6940785	5004	3.6993173	5064	3.7044937	5124	3.7096091	5184	3.7146650
4945	3.6941663	5005	3.6994041	5065	3.7045794	5125	3.7096939	5185	3.7147488
4946	3.6942541	5006	3.6994908	5066	3.7046652	5126	3.7097785	5186	3.7148325
4947	3.6943419	5007	3.6995776	5067	3.7047509	5127	3.7098633	5187	3.7149162
4948	3.6944297	5008	3.6996643	5068	3.7048366	5128	3.7099480	5188	3.7150000
4949	3.6945174	5009	3.6997510	5069	3.7049223	5129	3.7100327	5189	3.7150837
4950	3.6946052	5010	3.6998377	5070	3.7050079	5130	3.7101174	5190	3.7151673
4951	3.6946929	5011	3.6999244	5071	3.7050936	5131	3.7102020	5191	3.7152510
4952	3.6947806	5012	3.7000111	5072	3.7051792	5132	3.7102866	5192	3.7153347
4953	3.6948683	5013	3.7000977	5073	3.7052649	5133	3.7103713	5193	3.7154183
4954	3.6949560	5014	3.7001843	5074	3.7053505	5134	3.7104559	5194	3.7155019
4955	3.6950436	5015	3.7002709	5075	3.7054360	5135	3.7105404	5195	3.7155855
4956	3.6951313	5016	3.7003575	5076	3.7055216	5136	3.7106250	5196	3.7156691
4957	3.6952189	5017	3.7004441	5077	3.7056072	5137	3.7107096	5197	3.7157527
4958	3.6953065	5018	3.7005306	5078	3.7056927	5138	3.7107941	5198	3.7158363
4959	3.6953941	5019	3.7006172	5079	3.7057782	5139	3.7108786	5199	3.7159198
4960	3.6954817	5020	3.7007037	5080	3.7058637	5140	3.7109631	5200	3.7160033

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
5201	3.7160868	5261	3.7210683	5321	3.7259932	5381	3.7308630	5441	3.7356787
5202	3.7161703	5262	3.7211508	5322	3.7260749	5382	3.7309437	5442	3.7357585
5203	3.7162538	5263	3.7212334	5323	3.7261565	5383	3.7310244	5443	3.7358383
5204	3.7163373	5264	3.7213159	5324	3.7262380	5384	3.7311050	5444	3.7359181
5205	3.7164207	5265	3.7213984	5325	3.7263196	5385	3.7311857	5445	3.7359979
5206	3.7165042	5266	3.7214808	5326	3.7264012	5386	3.7312663	5446	3.7360775
5207	3.7165876	5267	3.7215633	5327	3.7264827	5387	3.7313470	5447	3.7361574
5208	3.7166710	5268	3.7216458	5328	3.7265642	5388	3.7314276	5448	3.7362371
5209	3.7167543	5269	3.7217282	5329	3.7266457	5389	3.7315082	5449	3.7363168
5210	3.7168377	5270	3.7218109	5330	3.7267272	5390	3.7315888	5450	3.7363965
5211	3.7169211	5271	3.7218930	5331	3.7268087	5391	3.7316693	5451	3.7364762
5212	3.7170044	5272	3.7219754	5332	3.7268901	5392	3.7317499	5452	3.7365558
5213	3.7170877	5273	3.7220578	5333	3.7269716	5393	3.7318304	5453	3.7366355
5214	3.7171710	5274	3.7221401	5334	3.7270530	5394	3.7319109	5454	3.7367151
5215	3.7172543	5275	3.7222225	5335	3.7271344	5395	3.7319914	5455	3.7367947
5216	3.7173376	5276	3.7223048	5336	3.7272158	5396	3.7320719	5456	3.7368744
5217	3.7174208	5277	3.7223871	5337	3.7272972	5397	3.7321524	5457	3.7369539
5218	3.7175041	5278	3.7224694	5338	3.7273786	5398	3.7322329	5458	3.7370335
5219	3.7175873	5279	3.7225517	5339	3.7274599	5399	3.7323133	5459	3.7371131
5220	3.7176705	5280	3.7226339	5340	3.7275412	5400	3.7323937	5460	3.7371925
5221	3.7177537	5281	3.7227162	5341	3.7276226	5401	3.7324742	5461	3.7372722
5222	3.7178339	5282	3.7227983	5342	3.7277039	5402	3.7325546	5462	3.7373517
5223	3.7179200	5283	3.7228806	5343	3.7277852	5403	3.7326350	5463	3.7374312
5224	3.7180032	5284	3.7229628	5344	3.7278664	5404	3.7327153	5464	3.7375107
5225	3.7180863	5285	3.7230450	5345	3.7279477	5405	3.7327957	5465	3.7375902
5226	3.7181694	5286	3.7231271	5346	3.7280289	5406	3.7328760	5466	3.7376696
5227	3.7182525	5287	3.7232093	5347	3.7281102	5407	3.7329564	5467	3.7377491
5228	3.7183356	5288	3.7232914	5348	3.7281914	5408	3.7330367	5468	3.7378286
5229	3.7184186	5289	3.7233736	5349	3.7282725	5409	3.7331170	5469	3.7379079
5230	3.7185017	5290	3.7234557	5350	3.7283538	5410	3.7331973	5470	3.7379873
5231	3.7185847	5291	3.7235378	5351	3.7284349	5411	3.7332775	5471	3.7380667
5232	3.7186677	5292	3.7236198	5352	3.7285161	5412	3.7333578	5472	3.7381461
5233	3.7187507	5293	3.7237019	5353	3.7285972	5413	3.7334380	5473	3.7382254
5234	3.7188337	5294	3.7237839	5354	3.7286784	5414	3.7335182	5474	3.7383048
5235	3.7189167	5295	3.7238660	5355	3.7287595	5415	3.7335985	5475	3.7383841
5236	3.7189996	5296	3.7239480	5356	3.7288406	5416	3.7336785	5476	3.7384634
5237	3.7190826	5297	3.7240300	5357	3.7289216	5417	3.7337588	5477	3.7385427
5238	3.7191655	5298	3.7241119	5358	3.7290027	5418	3.7338390	5478	3.7386220
5239	3.7192484	5299	3.7241939	5359	3.7290837	5419	3.7339191	5479	3.7387013
5240	3.7193313	5300	3.7242759	5360	3.7291648	5420	3.7339993	5480	3.7387805
5241	3.7194141	5301	3.7243578	5361	3.7292458	5421	3.7340794	5481	3.7388598
5242	3.7194970	5302	3.7244397	5362	3.7293268	5422	3.7341595	5482	3.7389390
5243	3.7195798	5303	3.7245216	5363	3.7294078	5423	3.7342396	5483	3.7390182
5244	3.7196627	5304	3.7246035	5364	3.7294888	5424	3.7343197	5484	3.7390974
5245	3.7197455	5305	3.7246854	5365	3.7295697	5425	3.7343997	5485	3.7391766
5246	3.7198283	5306	3.7247672	5366	3.7296507	5426	3.7344798	5486	3.7392558
5247	3.7199111	5307	3.7248491	5367	3.7297316	5427	3.7345598	5487	3.7393350
5248	3.7199938	5308	3.7249309	5368	3.7298125	5428	3.7346398	5488	3.7394141
5249	3.7200766	5309	3.7250127	5369	3.7298934	5429	3.7347198	5489	3.7394932
5250	3.7201593	5310	3.7250945	5370	3.7299743	5430	3.7347998	5490	3.7395723
5251	3.7202420	5311	3.7251763	5371	3.7300551	5431	3.7348798	5491	3.7396514
5252	3.7203247	5312	3.7252581	5372	3.7301360	5432	3.7349598	5492	3.7397305
5253	3.7204074	5313	3.7253398	5373	3.7302168	5433	3.7350397	5493	3.7398096
5254	3.7204901	5314	3.7254215	5374	3.7302977	5434	3.7351196	5494	3.7398886
5255	3.7205727	5315	3.7255033	5375	3.7303785	5435	3.7351995	5495	3.7399677
5256	3.7206553	5316	3.7255850	5376	3.7304593	5436	3.7352794	5496	3.7400467
5257	3.7207380	5317	3.7256667	5377	3.7305400	5437	3.7353593	5497	3.7401257
5258	3.7208206	5318	3.7257483	5378	3.7306208	5438	3.7354392	5498	3.7402047
5259	3.7209032	5319	3.7258300	5379	3.7307015	5439	3.7355190	5499	3.7402837
5260	3.7209857	5320	3.7259116	5380	3.7307823	5440	3.7355989	5500	3.7403627

Ten Chiliads of Logarithms.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
5501	3.7404416	5561	3.7451529	5621	3.7498136	5681	3.7544248	5741	3.7589875
5502	3.7405206	5562	3.7452310	5622	3.7498908	5682	3.7545012	5742	3.7590632
5503	3.7405995	5563	3.7453090	5623	3.7499681	5683	3.7545776	5743	3.7591388
5504	3.7406784	5564	3.7453871	5624	3.7500453	5684	3.7546541	5744	3.7592144
5505	3.7407573	5565	3.7454652	5625	3.7501225	5685	3.7547305	5745	3.7592900
5506	3.7408362	5566	3.7455432	5626	3.7501997	5686	3.7548068	5746	3.7593656
5507	3.7409151	5567	3.7456212	5627	3.7502769	5687	3.7548832	5747	3.7594412
5508	3.7409939	5568	3.7456992	5628	3.7503541	5688	3.7549596	5748	3.7595167
5509	3.7410728	5569	3.7457772	5629	3.7504312	5589	3.7550359	5749	3.7595923
5510	3.7411516	5570	3.7458552	5630	3.7505084	5690	3.7551123	5750	3.7596678
5511	3.7412304	5571	3.7459331	5631	3.7505855	5691	3.7551886	5751	3.7597434
5512	3.7413092	5572	3.7460111	5632	3.7506626	5692	3.7552649	5752	3.7598189
5513	3.7413880	5573	3.7460890	5633	3.7507397	5693	3.7553412	5753	3.7598944
5514	3.7414668	5574	3.7461670	5634	3.7508168	5694	3.7554175	5754	3.7599698
5515	3.7415455	5575	3.7462449	5635	3.7508939	5695	3.7554937	5755	3.7600453
5516	3.7416242	5576	3.7463228	5636	3.7509710	5696	3.7555700	5756	3.7601208
5517	3.7417030	5577	3.7464006	5637	3.7510480	5697	3.7556462	5757	3.7601962
5518	3.7417817	5578	3.7464785	5638	3.7511251	5698	3.7557224	5758	3.7602717
5519	3.7418604	5579	3.7465564	5639	3.7512021	5699	3.7557986	5759	3.7603471
5520	3.7419391	5580	3.7466342	5640	3.7512791	5700	3.7558748	5760	3.7604225
5521	3.7420177	5581	3.7467120	5641	3.7513561	5701	3.7559510	5761	3.7604979
5522	3.7420964	5582	3.7467898	5642	3.7514331	5702	3.7560272	5762	3.7605732
5523	3.7421750	5583	3.7468676	5643	3.7515190	5703	3.7561034	5763	3.7606486
5524	3.7422537	5584	3.7469454	5644	3.7515870	5704	3.7561795	5764	3.7607240
5525	3.7423323	5585	3.7470232	5645	3.7516639	5705	3.7562556	5765	3.7607993
5526	3.7424109	5586	3.7471009	5646	3.7517409	5706	3.7563318	5766	3.7608746
5527	3.7424895	5587	3.7471787	5647	3.7518178	5707	3.7564079	5767	3.7609494
5528	3.7425680	5588	3.7472564	5648	3.7518947	5708	3.7564840	5768	3.7610252
5529	3.7426466	5589	3.7473341	5649	3.7519716	5709	3.7565600	5769	3.7611005
5530	3.7427251	5590	3.7474118	5650	3.7520484	5710	3.7566361	5770	3.7611758
5531	3.7428036	5591	3.7474895	5651	3.7521253	5711	3.7567122	5771	3.7612511
5532	3.7428822	5592	3.7475672	5652	3.7522021	5712	3.7567882	5772	3.7613263
5533	3.7429607	5593	3.7476448	5653	3.7522790	5713	3.7568642	5773	3.7614015
5534	3.7430391	5594	3.7477229	5654	3.7523558	5714	3.7569402	5774	3.7614768
5535	3.7431176	5595	3.7478001	5655	3.7524326	5715	3.7570162	5775	3.7615520
5536	3.7431951	5596	3.7478777	5656	3.7525094	5716	3.7570922	5776	3.7616272
5537	3.7432745	5597	3.7479553	5657	3.7525862	5717	3.7571682	5777	3.7617024
5538	3.7433529	5598	3.7480329	5658	3.7526629	5718	3.7572441	5778	3.7617775
5539	3.7434314	5599	3.7481105	5659	3.7527397	5719	3.7573201	5779	3.7618527
5540	3.7435098	5600	3.7481880	5660	3.7528164	5720	3.7573960	5780	3.7619278
5541	3.7435881	5601	3.7482656	5661	3.7528931	5721	3.7574719	5781	3.7620030
5442	3.7436665	5602	3.7483431	5662	3.7529699	5722	3.7575478	5782	3.7620781
5543	3.7437449	5603	3.7484206	5663	3.7530466	5723	3.7576237	5783	3.7621532
5544	3.7438232	5604	3.7484981	5664	3.7531232	5724	3.7576996	5784	3.7622283
5545	3.7439015	5605	3.7485756	5665	3.7531999	5725	3.7577755	5785	3.7623034
5546	3.7439799	5606	3.7486531	5666	3.7532766	5726	3.7578513	5786	3.7623784
5547	3.7440582	5607	3.7487305	5667	3.7533532	5727	3.7579272	5787	3.7624535
5548	3.7441364	5608	3.7488080	5668	3.7534298	5728	3.7580030	5788	3.7625285
5549	3.7442147	5609	3.7488854	5669	3.7535064	5729	3.7580788	5789	3.7626035
5550	3.7442930	5610	3.7489629	5670	3.7535830	5730	3.7581546	5790	3.7626786
5551	3.7443712	5611	3.7490403	5671	3.7536596	5731	3.7582304	5791	3.7627536
5552	3.7444494	5612	3.7491177	5672	3.7537362	5732	3.7583062	5792	3.7628285
5553	3.7445277	5613	3.7491950	5673	3.7538128	5733	3.7583819	5793	3.7629035
5554	3.7446059	5614	3.7492724	5674	3.7538893	5734	3.7584577	5794	3.7629785
5555	3.7446841	5615	3.7493498	5675	3.7539659	5735	3.7585334	5795	3.7630534
5556	3.7447622	5616	3.7494271	5676	3.7540424	5736	3.7586091	5796	3.7631284
5557	3.7448404	5617	3.7495044	5677	3.7541189	5737	3.7586848	5797	3.7632033
5558	3.7449185	5618	3.7495817	5678	3.7541954	5738	3.7587605	5798	3.7632782
5559	3.7449967	5619	3.7496590	5679	3.7542719	5739	3.7588362	5799	3.7633531
5560	3.7450748	5620	3.7497363	5680	3.7543483	5740	3.7589119	5800	3.7634280

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
5801	3.7635029	5861	3.7679717	5921	3.7723951	5981	3.7767738	6041	3.7811088
5802	3.7635777	5862	3.7680458	5922	3.7724684	5982	3.7768464	6042	3.7811807
5803	3.7636525	5863	3.7681199	5923	3.7725417	5983	3.7769190	6043	3.7812525
5804	3.7637274	5864	3.7681940	5924	3.7726150	5984	3.7769916	6044	3.7813244
5805	3.7638022	5865	3.7682680	5925	3.7726883	5985	3.7770641	6045	3.7813963
5806	3.7638770	5866	3.7683420	5926	3.7727616	5986	3.7771367	6046	3.7814681
5807	3.7639518	5867	3.7684161	5927	3.7728349	5987	3.7772092	6047	3.7815400
5808	3.7640266	5868	3.7684901	5928	3.7729082	5988	3.7772818	6048	3.7816118
5809	3.7641014	5869	3.7685641	5929	3.7729814	5989	3.7773543	6049	3.7816836
5810	3.7641761	5870	3.7686381	5930	3.7730547	5990	3.7774268	6050	3.7817554
5811	3.7642509	5871	3.7687121	5931	3.7731279	5991	3.7774993	6051	3.7818271
5812	3.7643256	5872	3.7687860	5932	3.7732011	5992	3.7775718	6052	3.7818989
5813	3.7644003	5873	3.7688600	5933	3.7732743	5993	3.7776443	6053	3.7819707
5814	3.7644750	5874	3.7689339	5934	3.7733475	5994	3.7777167	6054	3.7820424
5815	3.7645497	5875	3.7690079	5935	3.7734207	5995	3.7777892	6055	3.7821141
5816	3.7646244	5876	3.7690808	5936	3.7734939	5996	3.7778616	6056	3.7821859
5817	3.7646991	5877	3.7691557	5937	3.7735670	5997	3.7779340	6057	3.7822576
5818	3.7647737	5878	3.7692296	5938	3.7736402	5998	3.7780065	6058	3.7823293
5819	3.7648483	5879	3.7693035	5939	3.7737133	5999	3.7780789	6059	3.7824009
5820	3.7649230	5880	3.7693773	5940	3.7737864	6000	3.7781512	6060	3.7824726
5821	3.7649976	5881	3.7694512	5941	3.7738595	6001	3.7782236	6061	3.7825443
5822	3.7650722	5882	3.7695250	5942	3.7739326	6002	3.7782960	6062	3.7826159
5823	3.7651468	5883	3.7695988	5943	3.7740057	6003	3.7783683	6063	3.7826876
5824	3.7652214	5884	3.7696727	5944	3.7740788	6004	3.7784407	6064	3.7827592
5825	3.7652959	5885	3.7697465	5945	3.7741518	6005	3.7785130	6065	3.7828308
5826	3.7653705	5886	3.7698202	5946	3.7742249	6006	3.7785853	6066	3.7829024
5827	3.7654450	5887	3.7698940	5947	3.7742979	6007	3.7786576	6067	3.7829740
5828	3.7655195	5888	3.7699678	5948	3.7743709	6008	3.7787299	6068	3.7830456
5829	3.7655940	5889	3.7700415	5949	3.7744440	6009	3.7788022	6069	3.7831171
5830	3.7656685	5890	3.7701153	5950	3.7745170	6010	3.7788745	6070	3.7831887
5831	3.7657430	5891	3.7701890	5951	3.7745899	6011	3.7789467	6071	3.7832602
5832	3.7658175	5892	3.7702627	5952	3.7746629	6012	3.7790190	6072	3.7833318
5833	3.7658920	5893	3.7703364	5953	3.7747359	6013	3.7790912	6073	3.7834033
5834	3.7659664	5894	3.7704101	5954	3.7748088	6014	3.7791634	6074	3.7834748
5835	3.7660409	5895	3.7704838	5955	3.7748818	6015	3.7792356	6075	3.7835463
5836	3.7661153	5896	3.7705575	5956	3.7749547	6016	3.7793078	6076	3.7836178
5837	3.7661897	5897	3.7706311	5957	3.7750276	6017	3.7793800	6077	3.7836892
5838	3.7662641	5898	3.7707048	5958	3.7751005	6018	3.7794522	6078	3.7837607
5839	3.7663385	5899	3.7707784	5959	3.7751734	6019	3.7795243	6079	3.7838321
5840	3.7664128	5900	3.7708520	5960	3.7752462	6020	3.7795965	6080	3.7839036
5841	3.7664872	5901	3.7709256	5961	3.7753191	6021	3.7796686	6081	3.7839750
5842	3.7665615	5902	3.7709992	5962	3.7753920	6022	3.7797407	6082	3.7840464
5843	3.7666359	5903	3.7710728	5963	3.7754648	6023	3.7798129	6083	3.7841178
5844	3.7667107	5904	3.7711463	5964	3.7755376	6024	3.7798850	6084	3.7841892
5845	3.7667845	5905	3.7712199	5965	3.7756104	6025	3.7799570	6085	3.7842606
5846	3.7668588	5906	3.7712934	5966	3.7756832	6026	3.7800291	6086	3.7843319
5847	3.7669331	5907	3.7713670	5967	3.7757560	6027	3.7801012	6087	3.7844033
5848	3.7670074	5908	3.7714405	5968	3.7758288	6028	3.7801732	6088	3.7844746
5849	3.7670816	5909	3.7715140	5969	3.7759016	6029	3.7802453	6089	3.7845460
5850	3.7671559	5910	3.7715875	5970	3.7759743	6030	3.7803173	6090	3.7846173
5851	3.7672301	5911	3.7716609	5971	3.7760471	6031	3.7803893	6091	3.7846886
5852	3.7673043	5912	3.7717344	5972	3.7761198	6032	3.7804613	6092	3.7847599
5853	3.7673785	5913	3.7718079	5973	3.7761925	6033	3.7805333	6093	3.7848312
5854	3.7674527	5914	3.7718813	5974	3.7762652	6034	3.7806053	6094	3.7849024
5855	3.7675269	5915	3.7719547	5975	3.7763379	6035	3.7806773	6095	3.7849737
5856	3.7676011	5916	3.7720282	5976	3.7764106	6036	3.7807492	6096	3.7850449
5857	3.7676752	5917	3.7721016	5977	3.7764832	6037	3.7808212	6097	3.7851162
5858	3.7677494	5918	3.7721750	5978	3.7765559	6038	3.7808931	6098	3.7851874
5859	3.7678235	5919	3.7722483	5979	3.7766285	6039	3.7809650	6099	3.7852586
5860	3.7678976	5920	3.7723217	5980	3.7767012	6040	3.7810369	6100	3.7853298

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
6101	3.7854010	6151	3.7896512	6221	3.7938602	6281	3.7980288	6341	3.8021577
6102	3.7854722	6162	3.7897217	6222	3.7939300	6282	3.7980979	6342	3.8022262
6103	3.7855434	6163	3.7897922	6223	3.7939998	6283	3.7981670	6343	3.8022947
6104	3.7856145	6164	3.7898626	6224	3.7940696	6284	3.7982362	6344	3.8023632
6105	3.7856857	6165	3.7899331	6225	3.7941393	6285	3.7983053	6345	3.8024316
6106	3.7857568	6166	3.7900035	6226	3.7942091	6286	3.7983744	6346	3.8025001
6107	3.7858279	6167	3.7900739	6227	3.7942789	6287	3.7984435	6347	3.8025685
6108	3.7858990	6168	3.7901444	6228	3.7943486	6288	3.7985125	6348	3.8026369
6109	3.7859701	6169	3.7902148	6229	3.7944183	6289	3.7985816	6349	3.8027053
6110	3.7860412	6170	3.7902852	6230	3.7944880	6290	3.7986506	6350	3.8027737
6111	3.7861123	6171	3.7903555	6231	3.7945577	6291	3.7987197	6351	3.8028421
6112	3.7861833	6172	3.7904259	6232	3.7946274	6292	3.7987887	6352	3.8029105
6113	3.7862544	6173	3.7904963	6233	3.7946971	6293	3.7988577	6353	3.8029788
6114	3.7863254	6174	3.7905666	6234	3.7947668	6294	3.7989267	6354	3.8030472
6115	3.7863965	6175	3.7906370	6235	3.7948364	6295	3.7989957	6355	3.8031155
6116	3.7864675	6176	3.7907073	6236	3.7949061	6296	3.7990647	6356	3.8031839
6117	3.7865385	6177	3.7907776	6237	3.7949757	6297	3.7991337	6357	3.8032522
6118	3.7866095	6178	3.7908479	6238	3.7950454	6298	3.7992026	6358	3.8033205
6119	3.7866804	6179	3.7909182	6239	3.7951150	6299	3.7992716	6359	3.8033888
6120	3.7867514	6180	3.7909885	6240	3.7951846	6300	3.7993405	6360	3.8034571
6121	3.7868224	6181	3.7910587	6241	3.7952542	6301	3.7994095	6361	3.8035254
6122	3.7868933	6182	3.7911290	6242	3.7953238	6302	3.7994784	6362	3.8035937
6123	3.7869642	6183	3.7911992	6243	3.7953933	6303	3.7995473	6363	3.8036619
6124	3.7870352	6184	3.7912695	6244	3.7954629	6304	3.7996162	6364	3.8037302
6125	3.7871061	6185	3.7913397	6245	3.7955324	6305	3.7996851	6365	3.8037984
6126	3.7871770	6186	3.7914099	6246	3.7956020	6306	3.7997540	6366	3.8038666
6127	3.7872479	6187	3.7914801	6247	3.7956715	6307	3.7998228	6367	3.8039348
6128	3.7873187	6188	3.7915503	6248	3.7957410	6308	3.7998917	6368	3.8040030
6129	3.7873896	6189	3.7916205	6249	3.7958105	6309	3.7999605	6369	3.8040712
6130	3.7874605	6190	3.7916906	6250	3.7958800	6310	3.8000293	6370	3.8041394
6131	3.7875313	6191	3.7917608	6251	3.7959495	6311	3.8000982	6371	3.8042076
6132	3.7876021	6192	3.7918309	6252	3.7960190	6312	3.8001670	6372	3.8042758
6133	3.7876730	6193	3.7919011	6253	3.7960884	6313	3.8002358	6373	3.8043439
6134	3.7877438	6194	3.7919712	6254	3.7961579	6314	3.8003046	6374	3.8044120
6135	3.7878146	6195	3.7920413	6255	3.7962273	6315	3.8003733	6375	3.8044802
6136	3.7878853	6196	3.7921114	6256	3.7962967	6316	3.8004421	6376	3.8045483
6137	3.7879561	6197	3.7921815	6257	3.7963661	6317	3.8005109	6377	3.8046164
6138	3.7880269	6198	3.7922516	6258	3.7964355	6318	3.8005796	6378	3.8046845
6139	3.7880976	6199	3.7923216	6259	3.7965049	6319	3.8006483	6379	3.8047526
6140	3.7881684	6200	3.7923917	6260	3.7965743	6320	3.8007171	6380	3.8048207
6141	3.7882391	6201	3.7924617	6261	3.7966437	6321	3.8007858	6381	3.8048887
6142	3.7883098	6202	3.7925318	6262	3.7967131	6322	3.8008545	6382	3.8049568
6143	3.7883805	6203	3.7926018	6263	3.7967824	6323	3.8009232	6383	3.8050248
6144	3.7884512	6204	3.7926718	6264	3.7968517	6324	3.8009919	6384	3.8050929
6145	3.7885219	6205	3.7927418	6265	3.7969211	6325	3.8010605	6385	3.8051609
6146	3.7885925	6206	3.7928118	6266	3.7969904	6326	3.8011292	6386	3.8052289
6147	3.7886632	6207	3.7928817	6267	3.7970597	6327	3.8011978	6387	3.8052969
6148	3.7887338	6208	3.7929517	6268	3.7971290	6328	3.8012665	6388	3.8053649
6149	3.7888045	6209	3.7930216	6269	3.7971983	6329	3.8013351	6389	3.8054329
6150	3.7888751	6210	3.7930916	6270	3.7972675	6330	3.8014037	6390	3.8055008
6151	3.7889457	6211	3.7931615	6271	3.7973368	6331	3.8014723	6391	3.8055688
6152	3.7890163	6212	3.7932314	6272	3.7974060	6332	3.8015409	6392	3.8056368
6153	3.7890869	6213	3.7933013	6273	3.7974753	6333	3.8016095	6393	3.8057047
6154	3.7891575	6214	3.7933712	6274	3.7975445	6334	3.8016780	6394	3.8057726
6155	3.7892280	6215	3.7934411	6275	3.7976137	6335	3.8017466	6395	3.8058405
6156	3.7892986	6216	3.7935110	6276	3.7976829	6336	3.8018152	6396	3.8059084
6157	3.7893691	6217	3.7935809	6277	3.7977521	6337	3.8018837	6397	3.8059763
6158	3.7894397	6218	3.7936507	6278	3.7978213	6338	3.8019522	6398	3.8060442
6159	3.7895102	6219	3.7937205	6279	3.7978905	6339	3.8020207	6399	3.8061121
6160	3.7895807	6220	3.7937904	6280	3.7979596	6340	3.8020892	6400	3.8061800

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
6401	3.8062473	6461	3.8102997	6521	3.8143142	6581	3.8182919	6641	3.8222335
6402	3.8063157	6462	3.8103669	6522	3.8143803	6582	3.8183579	6642	3.8222989
6403	3.8063835	6463	3.8104341	6523	3.8144474	6583	3.8184238	6643	3.8223642
6404	3.8064513	6464	3.8105013	6524	3.8145139	6584	3.8184898	6644	3.8224296
6405	3.8065191	6465	3.8105685	6525	3.8145805	6585	3.8185558	6645	3.8224950
6406	3.8065869	6466	3.8106357	6526	3.8146471	6586	3.8186217	6646	3.8225603
6407	3.8066547	6467	3.8107029	6527	3.8147136	6587	3.8186877	6647	3.8226257
6408	3.8067225	6468	3.8107700	6528	3.8147801	6588	3.8187536	6648	3.8226910
6409	3.8067903	6469	3.8108371	6529	3.8148467	6589	3.8188195	6649	3.8227563
6410	3.8068580	6470	3.8109043	6530	3.8149132	6590	3.8188854	6650	3.8228216
6411	3.8069258	6471	3.8109714	6531	3.8149797	6591	3.8189513	6651	3.8228869
6412	3.8069935	6472	3.8110385	6532	3.8150462	6592	3.8190172	6652	3.8229522
6413	3.8070612	6473	3.8111056	6533	3.8151126	6593	3.8190831	6653	3.8230175
6414	3.8071289	6474	3.8111727	6534	3.8151791	6594	3.8191489	6654	3.8230828
6415	3.8071967	6475	3.8112398	6535	3.8152456	6595	3.8192148	6655	3.8231480
6416	3.8072643	6476	3.8113068	6536	3.8153120	6596	3.8192806	6656	3.8232133
6417	3.8073320	6477	3.8113739	6537	3.8153785	6597	3.8193465	6657	3.8232785
6418	3.8073997	6478	3.8114409	6538	3.8154449	6598	3.8194123	6658	3.8233438
6419	3.8074674	6479	3.8115080	6539	3.8155113	6599	3.8194781	6659	3.8234090
6420	3.8075350	6480	3.8115750	6540	3.8155777	6600	3.8195439	6660	3.8234742
6421	3.8076027	6481	3.8116420	6541	3.8156441	6601	3.8196097	6661	3.8235394
6422	3.8076703	6482	3.8117090	6542	3.8157105	6602	3.8196755	6662	3.8236046
6423	3.8077379	6483	3.8117760	6543	3.8157769	6603	3.8197413	6663	3.8236698
6424	3.8078055	6484	3.8118430	6544	3.8158433	6604	3.8198071	6664	3.8237350
6425	3.8078731	6485	3.8119100	6545	3.8159096	6605	3.8198728	6665	3.8238001
6426	3.8079407	6486	3.8119769	6546	3.8159760	6606	3.8199386	6666	3.8238653
6427	3.8080083	6487	3.8120439	6547	3.8160423	6607	3.8200043	6667	3.8239304
6428	3.8080759	6488	3.8121108	6548	3.8161087	6608	3.8200700	6668	3.8239956
6429	3.8081434	6489	3.8121778	6549	3.8161750	6609	3.8201357	6669	3.8240607
6430	3.8082110	6490	3.8122447	6550	3.8162413	6610	3.8202014	6670	3.8241258
6431	3.8082785	6491	3.8123116	6551	3.8163076	6611	3.8202671	6671	3.8241909
6432	3.8083460	6492	3.8123785	6552	3.8163739	6612	3.8203328	6672	3.8242560
6433	3.8084135	6493	3.8124454	6553	3.8164402	6613	3.8203985	6673	3.8243211
6434	3.8084810	6494	3.8125123	6554	3.8165064	6614	3.8204542	6674	3.8243862
6435	3.8085485	6495	3.8125791	6555	3.8165727	6615	3.8205298	6675	3.8244513
6436	3.8086160	6496	3.8126460	6556	3.8166389	6616	3.8205955	6676	3.8245163
6437	3.8086835	6497	3.8127129	6557	3.8167052	6617	3.8206611	6677	3.8245814
6438	3.8087510	6498	3.8127797	6558	3.8167714	6618	3.8207268	6678	3.8246464
6439	3.8088184	6499	3.8128465	6559	3.8168376	6619	3.8207924	6679	3.8247114
6440	3.8088859	6500	3.8129133	6560	3.8169038	6620	3.8208580	6680	3.8247765
6441	3.8089533	6501	3.8129802	6561	3.8169700	6621	3.8209236	6681	3.8248415
6442	3.8090207	6502	3.8130470	6562	3.8170362	6622	3.8209892	6682	3.8249065
6443	3.8090881	6503	3.8131137	6563	3.8171024	6623	3.8210547	6683	3.8249715
6444	3.8091555	6504	3.8131805	6564	3.8171686	6624	3.8211203	6684	3.8250364
6445	3.8092229	6505	3.8132473	6565	3.8172347	6625	3.8211859	6685	3.8251014
6446	3.8092903	6506	3.8133140	6566	3.8173009	6626	3.8212514	6686	3.8251664
6447	3.8093577	6507	3.8133808	6567	3.8173670	6627	3.8213170	6687	3.8252313
6448	3.8094250	6508	3.8134475	6568	3.8174331	6628	3.8213825	6688	3.8252963
6449	3.8094924	6509	3.8135143	6569	3.8174993	6629	3.8214480	6689	3.8253612
6450	3.8095597	6510	3.8135810	6570	3.8175654	6630	3.8215135	6690	3.8254261
6451	3.8096270	6511	3.8136477	6571	3.8176315	6631	3.8215790	6691	3.8254910
6452	3.8096943	6512	3.8137144	6572	3.8176975	6632	3.8216445	6692	3.8255559
6453	3.8097617	6513	3.8137811	6573	3.8177636	6633	3.8217100	6693	3.8256208
6454	3.8098290	6514	3.8138477	6574	3.8178297	6634	3.8217755	6694	3.8256857
6455	3.8098962	6515	3.8139144	6575	3.8178957	6635	3.8218409	6695	3.8257506
6456	3.8099635	6516	3.8139811	6576	3.8179618	6636	3.8219064	6696	3.8258154
6457	3.8100308	6517	3.8140477	6577	3.8180278	6637	3.8219718	6697	3.8258803
6458	3.8100980	6518	3.8141143	6578	3.8180939	6638	3.8220372	6698	3.8259451
6459	3.8101653	6519	3.8141810	6579	3.8181599	6639	3.8221027	6699	3.8260100
6460	3.8102325	6520	3.8142476	6580	3.8182259	6640	3.8221681	6700	3.8260748

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
6701	3.8261396	6761	3.8300109	6821	3.8338480	6831	3.8376515	6941	3.8414230
6702	3.8262044	6762	3.8300752	6822	3.8339117	6882	3.8377147	6942	3.8414846
6703	3.8262692	6763	3.8301394	6823	3.8339754	6883	3.8377778	6943	3.8415472
6704	3.8263340	6764	3.8302036	6824	3.8340390	6384	3.8378409	6944	3.8416097
6705	3.8263988	6765	3.8302678	6825	3.8341025	6885	3.8379039	6945	3.8416722
6706	3.8264635	6766	3.8303320	6826	3.8341663	6386	3.8379670	6946	3.8417348
6707	3.8265283	6767	3.8303962	6827	3.8342299	6387	3.8380301	6947	3.8417973
6708	3.8265930	6768	3.8304603	6828	3.8342935	6388	3.8380931	6948	3.8418598
6709	3.8266578	6769	3.8305245	6829	3.8343571	6889	3.8381562	6949	3.8419223
6710	3.8267225	6770	3.8305887	6830	3.8344207	6890	3.8382192	6950	3.8419848
6711	3.8267872	6771	3.8306528	6831	3.8344843	6891	3.8382822	6951	3.8420473
6712	3.8268519	6772	3.8307169	6832	3.8345478	6892	3.8383453	6952	3.8421098
6713	3.8269166	6773	3.8307811	6833	3.8346114	6893	3.8384083	6953	3.8421722
6714	3.8269813	6774	3.8308452	6834	3.8346750	6394	3.8384713	6954	3.8422347
6715	3.8270460	6775	3.8309093	6835	3.8347385	6895	3.8385343	6955	3.8422971
6716	3.8271107	6776	3.8309734	6836	3.8348020	6896	3.8385972	6956	3.8423596
6717	3.8271753	6777	3.8310375	6837	3.8348656	6897	3.8386602	6957	3.8424220
6718	3.8272400	6778	3.8311016	6838	3.8349291	6898	3.8387232	6958	3.8424844
6719	3.8273046	6779	3.8311656	6839	3.8349926	6399	3.8387361	6959	3.8425468
6720	3.8273693	6780	3.8312297	6840	3.8350561	6900	3.8388491	6960	3.8426092
6721	3.8274339	6781	3.8312937	6841	3.8351196	6901	3.8389120	6961	3.8426716
6722	3.8274985	6782	3.8313578	6842	3.8351831	6902	3.8389749	6962	3.8427340
6723	3.8275631	6783	3.8314218	6843	3.8352465	6903	3.8390379	6963	3.8427964
6724	3.8276277	6784	3.8314858	6844	3.8353100	6904	3.8391008	6964	3.8428588
6725	3.8276923	6785	3.8315498	6845	3.8353734	6905	3.8391637	6965	3.8429211
6726	3.8277569	6786	3.8316138	6846	3.8354369	6906	3.8392265	6966	3.8429835
6727	3.8278214	6787	3.8316778	6847	3.8355003	6907	3.8392894	6967	3.8430458
6728	3.8278860	6788	3.8317418	6848	3.8355637	6908	3.8393523	6968	3.8431081
6729	3.8279505	6789	3.8318058	6849	3.8356272	6909	3.8394152	6969	3.8431705
6730	3.8280151	6790	3.8318698	6850	3.8356906	6910	3.8394780	6970	3.8432328
6731	3.8280796	6791	3.8319337	6851	3.8357540	6911	3.8395409	6971	3.8432951
6732	3.8281441	6792	3.8319977	6852	3.8358173	6912	3.8396037	6972	3.8433574
6733	3.8282086	6793	3.8320616	6853	3.8358807	6913	3.8396665	6973	3.8434197
6734	3.8282731	6794	3.8321255	6854	3.8359441	6914	3.8397294	6974	3.8434819
6735	3.8283376	6795	3.8321895	6855	3.8360074	6915	3.8397922	6975	3.8435442
6736	3.8284021	6796	3.8322534	6856	3.8360708	6916	3.8398550	6976	3.8436065
6737	3.8284665	6797	3.8323173	6857	3.8361341	6917	3.8399178	6977	3.8436687
6738	3.8285310	6798	3.8323812	6858	3.8361975	6918	3.8399805	6978	3.8437310
6739	3.8285954	6799	3.8324450	6859	3.8362608	6919	3.8400433	6979	3.8437932
6740	3.8286569	6800	3.8325089	6860	3.8363241	6920	3.8401001	6980	3.8438554
6741	3.8287243	6801	3.8325728	6861	3.8363874	6921	3.8401688	6981	3.8439176
6742	3.8287887	6802	3.8326366	6862	3.8364507	6922	3.8402316	6982	3.8439798
6743	3.8288531	6803	3.8327005	6863	3.8365140	6923	3.8402943	6983	3.8440420
6744	3.8289176	6804	3.8327643	6864	3.8365773	6924	3.8403570	6984	3.8441042
6745	3.8289819	6805	3.8328281	6865	3.8366405	6925	3.8404198	6985	3.8441664
6746	3.8290463	6806	3.8328919	6866	3.8367038	6926	3.8404825	6986	3.8442286
6747	3.8291107	6807	3.8329557	6867	3.8367670	6927	3.8405452	6987	3.8442907
6748	3.8291751	6808	3.8330195	6868	3.8368303	6928	3.8406079	6988	3.8443529
6749	3.8292394	6809	3.8330833	6869	3.8368935	6929	3.8406706	6989	3.8444150
6750	3.8293038	6810	3.8331471	6870	3.8369567	6930	3.8407332	6990	3.8444772
6751	3.8293681	6811	3.8332109	6871	3.8370199	6931	3.8407959	6991	3.8445393
6752	3.8294324	6812	3.8332746	6872	3.8370831	6932	3.8408585	6992	3.8446014
6753	3.8294967	6813	3.8333384	6873	3.8371403	6933	3.8409212	6993	3.8446635
6754	3.8295610	6814	3.8334021	6874	3.8372095	6934	3.8409838	6994	3.8447256
6755	3.8296253	6815	3.8334659	6875	3.8372727	6935	3.8410405	6995	3.8447877
6756	3.8296896	6816	3.8335296	6876	3.8373359	6936	3.8411091	6996	3.8448498
6757	3.8297539	6817	3.8335933	6877	3.8373990	6937	3.8411717	6997	3.8449119
6758	3.8298182	6818	3.8336570	6878	3.8374622	6938	3.8412343	6998	3.8449739
6759	3.8298824	6819	3.8337207	6879	3.8375253	6939	3.8412969	6999	3.8450360
6760	3.8299467	6820	3.8337844	6880	3.8375884	6940	3.8413595	7000	3.8450980

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
7001	3.8451600	7061	3.8488662	7121	3.8525410	7181	3.8561849	7241	3.8597985
7002	3.8452221	7062	3.8489277	7122	3.8526020	7182	3.8562454	7242	3.8598585
7003	3.8452841	7063	3.8489892	7123	3.8526629	7183	3.8563059	7243	3.8599185
7004	3.8453461	7064	3.8490507	7124	3.8527239	7184	3.8563663	7244	3.8599784
7005	3.8454081	7065	3.8491122	7125	3.8527849	7185	3.8564268	7245	3.8600384
7006	3.8454701	7066	3.8491736	7126	3.8528458	7186	3.8564872	7246	3.8600983
7007	3.8455321	7067	3.8492351	7127	3.8529067	7187	3.8565476	7247	3.8601583
7008	3.8455941	7068	3.8492965	7128	3.8529677	7188	3.8566081	7248	3.8602182
7009	3.8456561	7069	3.8493580	7129	3.8530286	7189	3.8566685	7249	3.8602781
7010	3.8457180	7070	3.8494194	7130	3.8530895	7190	3.8567289	7250	3.8603380
7011	3.8457800	7071	3.8494808	7131	3.8531504	7191	3.8567893	7251	3.8603979
7012	3.8458419	7072	3.8495422	7132	3.8532113	7192	3.8568497	7252	3.8604578
7013	3.8459038	7073	3.8496036	7133	3.8532722	7193	3.8569101	7253	3.8605177
7014	3.8459658	7074	3.8496650	7134	3.8533331	7194	3.8569704	7254	3.8605775
7015	3.8460277	7075	3.8497264	7135	3.8533940	7195	3.8570308	7255	3.8606374
7016	3.8460896	7076	3.8497878	7136	3.8534548	7196	3.8570911	7256	3.8606973
7017	3.8461515	7077	3.8498492	7137	3.8535157	7197	3.8571515	7257	3.8607571
7018	3.8462134	7078	3.8499105	7138	3.8535765	7198	3.8572118	7258	3.8608170
7019	3.8462752	7079	3.8499719	7139	3.8536374	7199	3.8572722	7259	3.8608768
7020	3.8463371	7080	3.8500332	7140	3.8536982	7200	3.8573325	7260	3.8609366
7021	3.8463990	7081	3.8500946	7141	3.8537590	7201	3.8573928	7261	3.8609964
7022	3.8464608	7082	3.8501559	7142	3.8538198	7202	3.8574531	7262	3.8610562
7023	3.8465227	7083	3.8502172	7143	3.8538806	7203	3.8575134	7263	3.8611160
7024	3.8465845	7084	3.8502785	7144	3.8539414	7204	3.8575737	7264	3.8611758
7025	3.8466463	7085	3.8503398	7145	3.8540022	7205	3.8576340	7265	3.8612356
7026	3.8467081	7086	3.8504011	7146	3.8540630	7206	3.8576942	7266	3.8612954
7027	3.8467699	7087	3.8504624	7147	3.8541238	7207	3.8577545	7267	3.8613552
7028	3.8468317	7088	3.8505237	7148	3.8541845	7208	3.8578148	7268	3.8614149
7029	3.8468935	7089	3.8505850	7149	3.8542453	7209	3.8578750	7269	3.8614747
7030	3.8469553	7090	3.8506462	7150	3.8543060	7210	3.8579353	7270	3.8615344
7031	3.8470171	7091	3.8507075	7151	3.8543668	7211	3.8579955	7271	3.8615941
7032	3.8470789	7092	3.8507687	7152	3.8544275	7212	3.8580557	7272	3.8616539
7033	3.8471406	7093	3.8508299	7153	3.8544882	7213	3.8581159	7273	3.8617136
7034	3.8472024	7094	3.8508912	7154	3.8545489	7214	3.8581761	7274	3.8617733
7035	3.8472641	7095	3.8509524	7155	3.8546096	7215	3.8582363	7275	3.8618330
7036	3.8473258	7096	3.8510136	7156	3.8546703	7216	3.8582965	7276	3.8618927
7037	3.8473875	7097	3.8510748	7157	3.8547310	7217	3.8583567	7277	3.8619524
7038	3.8474493	7098	3.8511360	7158	3.8547917	7218	3.8584169	7278	3.8620120
7039	3.8475110	7099	3.8511972	7159	3.8548524	7219	3.8584770	7279	3.8620717
7040	3.8475726	7100	3.8512583	7160	3.8549130	7220	3.8585372	7280	3.8621314
7041	3.8476343	7101	3.8513195	7161	3.8549737	7221	3.8585973	7281	3.8621910
7042	3.8476960	7102	3.8513807	7162	3.8550343	7222	3.8586575	7282	3.8622507
7043	3.8477577	7103	3.8514418	7163	3.8550949	7223	3.8587176	7283	3.8623103
7044	3.8478193	7104	3.8515 29	7164	3.8551556	7224	3.8587777	7284	3.8623699
7045	3.8478810	7105	3.8515641	7165	3.8552162	7225	3.8588378	7285	3.8624295
7046	3.8479426	7106	3.8516252	7166	3.8552768	7226	3.8588979	7286	3.8624892
7047	3.8480043	7107	3.8516863	7167	3.8553374	7227	3.8589580	7287	3.8625488
7048	3.8480659	7108	3.8517474	7168	3.8553980	7228	3.8590181	7288	3.8626084
7049	3.8481275	7109	3.8518085	7169	3.8554585	7229	3.8590782	7289	3.8626679
7050	3.8481891	7110	3.8518696	7170	3.8555191	7230	3.8591383	7290	3.8627275
7051	3.8482507	7111	3.8519307	7171	3.8555797	7231	3.8591984	7291	3.8627871
7052	3.8483123	7112	3.8519917	7172	3.8556403	7232	3.8592584	7292	3.8628467
7053	3.8483739	7113	3.8520528	7173	3.8557008	7233	3.8593185	7293	3.8629062
7054	3.8484354	7114	3.8521139	7174	3.8557614	7234	3.8593785	7294	3.8629657
7055	3.8484970	7115	3.8521749	7175	3.8558219	7235	3.8594385	7295	3.8630253
7056	3.8485586	7116	3.8522359	7176	3.8558824	7236	3.8594985	7296	3.8630848
7057	3.8486201	7117	3.8522970	7177	3.8559429	7237	3.8595586	7297	3.8631443
7058	3.8486816	7118	3.8523580	7178	3.8560034	7238	3.8596186	7298	3.8632038
7059	3.8487432	7119	3.8524190	7179	3.8560639	7239	3.8596786	7299	3.8632634
7060	3.8488047	7120	3.8524800	7180	3.8561244	7240	3.8597386	7300	3.8633229

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
7301	3.8633823	7361	3.8669368	7421	3.8704624	7481	3.8739596	7541	3.8774289
7302	3.8634418	7362	3.8669958	7422	3.8705209	7482	3.8740177	7542	3.8774865
7303	3.8635013	7363	3.8670548	7423	3.8705795	7483	3.8740757	7543	3.8775441
7304	3.8635608	7364	3.8671138	7424	3.8706380	7484	3.8741338	7544	3.8776017
7305	3.8636202	7365	3.8671727	7425	3.8706964	7485	3.8741918	7545	3.8776592
7306	3.8636797	7366	3.8672317	7426	3.8707549	7486	3.8742498	7546	3.8777168
7307	3.8637391	7367	3.8672907	7427	3.8708134	7487	3.8743078	7547	3.8777743
7308	3.8637985	7368	3.8673496	7428	3.8708719	7488	3.8743658	7548	3.8778319
7309	3.8638580	7369	3.8674085	7429	3.8709303	7489	3.8744238	7549	3.8778894
7310	3.8639174	7370	3.8674675	7430	3.8709888	7490	3.8744818	7550	3.8779464
7311	3.8639768	7371	3.8675264	7431	3.8710473	7491	3.8745398	7551	3.8780045
7312	3.8640362	7372	3.8675853	7432	3.8711057	7492	3.8745978	7552	3.8780620
7313	3.8640956	7373	3.8676442	7433	3.8711641	7493	3.8746557	7553	3.8781195
7314	3.8641549	7374	3.8677031	7434	3.8712225	7494	3.8747137	7554	3.8781770
7315	3.8642143	7375	3.8677620	7435	3.8712810	7495	3.8747716	7555	3.8782345
7316	3.8642737	7376	3.8678209	7436	3.8713394	7496	3.8748296	7556	3.8782919
7317	3.8643330	7377	3.8678798	7437	3.8713978	7497	3.8748875	7557	3.8783494
7318	3.8643924	7378	3.8679386	7438	3.8714562	7498	3.8749454	7558	3.8784069
7319	3.8644517	7379	3.8679975	7439	3.8715145	7499	3.8750033	7559	3.8784643
7320	3.8645111	7380	3.8680564	7440	3.8715729	7500	3.8750613	7560	3.8785218
7321	3.8645704	7381	3.8681152	7441	3.8716313	7501	3.8751192	7561	3.8785792
7322	3.8646297	7382	3.8681740	7442	3.8716897	7502	3.8751770	7562	3.8786367
7323	3.8646890	7383	3.8682329	7443	3.8717480	7503	3.8752349	7563	3.8786941
7324	3.8647483	7384	3.8682917	7444	3.8718064	7504	3.8752928	7564	3.8787515
7325	3.8648076	7385	3.8683505	7445	3.8718647	7505	3.8753507	7565	3.8788089
7326	3.8648669	7386	3.8684093	7446	3.8719230	7506	3.8754086	7566	3.8788663
7327.	3.8649262	7387	3.8684681	7447	3.8719813	7507	3.8754664	7567	3.8789237
7328	3.8649855	7388	3.8685269	7448	3.8720397	7508	3.8755243	7568	3.8789811
7329	3.8650447	7389	3.8685857	7449	3.8720980	7509	3.8755821	7569	3.8790385
7330	3.8651040	7390	3.8686444	7450	3.8721563	7510	3.8756399	7570	3.8790959
7331	3.8651632	7391	3.8687032	7451	3.8722146	7511	3.8756978	7571	3.8791532
7332	3.8652224	7392	3.8687619	7452	3.8722728	7512	3.8757556	7572	3.8792106
7333	3.8652817	7393	3.8688207	7453	3.8723311	7513	3.8758134	7573	3.8792679
7334	3.8653409	7394	3.8688794	7454	3.8723894	7514	3.8758712	7574	3.8793253
7335	3.8654001	7395	3.8689382	7455	3.8724476	7515	3.8759290	7575	3.8793826
7336	3.8654593	7396	3.8689569	7456	3.8725059	7516	3.8759868	7576	3.8794400
7337	3.8655185	7397	3.8690556	7457	3.8725641	7517	3.8760445	7577	3.8794973
7338	3.8655777	7398	3.8691143	7458	3.8726224	7518	3.8791023	7578	3.8795546
7339	3.8656369	7399	3.8691730	7459	3.8726806	7519	3.8761601	7579	3.8796119
7340	3.8656960	7400	3.8692317	7460	3.8727388	7520	3.8762178	7580	3.8796692
7341	3.8657552	7401	3.8692904	7461	3.8727970	7521	3.8762756	7581	3.8797265
7342	3.8658144	7402	3.8693491	7462	3.8728552	7522	3.8763333	7582	3.8797838
7343	3.8658735	7403	3.8694077	7463	3.8729134	7523	3.0763911	7583	3.8798410
7344	3.8659327	7404	3.8694664	7464	3.8729716	7524	3.8764488	7584	3.8798983
7345	3.8659918	7405	3.8695251	7465	3.8730298	7525	3.8765065	7585	3.8799556
7346	3.8660509	7406	3.8695837	7466	3.8730880	7526	3.8765642	7586	3.8800128
7347	3.8661100	7407	3.8696423	7467	3.8731461	7527	3.8766219	7587	3.8800701
7348	3.8661691	7408	3.8697010	7468	3.8732043	7528	3.8766796	7588	3.8801273
7349	3.8662282	7409	3.8697596	7469	3.8732624	7529	3.8767373	7589	3.8801845
7350	3.8662873	7410	3.8698182	7470	3.8733206	7530	3.8767950	7590	3.8802418
7351	3.8663464	7411	3.8698768	7471	3.8733787	7531	3.8768526	7591	3.8802999
7352	3.8664055	7412	3.8699354	7472	3.8734369	7532	3.8769103	7592	3.8803562
7353	3.8664646	7413	3.8699940	7473	3.8734950	7533	3.8769680	7593	3.8804134
7354	3.8665236	7414	3.8700526	7474	3.8735531	7534	3.8770256	7594	3.8804706
7355	3.8665827	7415	3.8701111	7475	3.8736112	7535	3.877[illegible]832	7595	3.8805278
7356	3.8666417	7416	3.8701697	7476	3.8736693	7536	3.8771409	7596	3.8805840
7357	3.8667007	7417	3.8702283	7477	3.8737274	7537	3.8771985	7597	3.8806421
7358	3.8667598	7418	3.8702868	7478	3.8737855	7538	3.8772561	7598	3.8806993
7359	3.8668188	7419	3.8703454	7479	3.8738435	7539	3.8773137	7599	3.8807564
7360	3.8668778	7420	3.8704039	7480	3.8739016	7540	3.8773713	7600	3.8808136

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
7601	3.8808707	7661	3.8842855	7721	3.8876735	7781	3.8910354	7841	3.8943714
7602	3.8809279	7662	3.8843421	7722	3.8877298	7782	3.8910912	7842	3.8944268
7603	3.8809850	7663	3.8843988	7723	3.8877860	7783	3.8911470	7843	3.8944822
7604	3.8810421	7664	3.8844555	7724	3.8878423	7784	3.8912028	7844	3.8945376
7605	3.8810992	7665	3.8845121	7725	3.8878985	7785	3.8912586	7845	3.8945929
7606	3.8811563	7666	3.8845688	7726	3.8879547	7786	3.8913144	7846	3.8946483
7607	3.8812134	7667	3.8846255	7727	3.8880109	7787	3.8913702	7847	3.8947036
7608	3.8812705	7668	3.8846821	7728	3.8880671	7788	3.8914259	7848	3.8947590
7609	3.8813276	7669	3.8847387	7729	3.8881233	7789	3.8914817	7849	3.8948143
7610	3.8813846	7670	3.8847954	7730	3.8881795	7790	3.8915374	7850	3.8948606
7611	3.8814417	7671	3.8848520	7731	3.8882357	7791	3.8915932	7851	3.8949250
7612	3.8814988	7672	3.8849086	7732	3.8882918	7792	3.8916489	7852	3.8949803
7613	3.8815558	7673	3.8849652	7733	3.8883480	7793	3.8917047	7853	3.8950356
7614	3.8816129	7674	3.8850218	7734	3.8884042	7794	3.8917604	7854	3.8950909
7615	3.8816699	7675	3.8850784	7735	3.8884603	7795	3.8918161	7855	3.8951462
7616	3.8817269	7676	3.8851350	7736	3.8885165	7796	3.8918718	7856	3.8952015
7617	3.8817839	7677	3.8851915	7737	3.8885726	7797	3.8919275	7857	3.8952567
7618	3.8818410	7678	3.8852481	7738	3.8386287	7798	3.8919832	7858	3.8953120
7619	3.8818980	7679	3.8853047	7739	3.8886848	7799	3.8920389	7859	3.8953673
7620	3.8819550	7680	3.8853612	7740	3 8887410	7800	3.8920946	7860	3.8954225
7621	3.8820120	7681	3.8854178	7741	3.8887971	7801	3.8921503	7861	3.8954778
7622	3.8820689	7682	3.8854743	7742	3.8888532	7802	3.8922059	7862	3.8955330
7623	3.8821259	7683	3.8855308	7743	3.8889092	7803	3.8922616	7863	3.8955883
7624	3.8821829	7684	3.8855873	7744	3.8889653	7804	3.8923173	7864	3.8956435
7625	3.8822398	7685	3.8856439	7745	3.8890214	7805	3.8923729	7865	3.8956987
7626	3.8822968	7686	3.8857004	7746	3.8890775	7806	3.8924285	7866	3.8957539
7627	3.8823537	7687	3.8857569	7747	3.8891335	7807	3.8924842	7867	3.8958091
7628	3.8824107	7688	3.8858134	7748	3.8891896	7808	3.8925398	7868	3.8958643
7629	3.8824676	7689	3.8858699	7749	3.8892457	7809	3.8925954	7869	3.8959195
7630	3.8825245	7690	3.8859263	7750	3.8893017	7810	3.8926510	7870	3.8959747
7631	3.8825814	7691	3.8859828	7751	3.8893577	7811	3.8927067	7871	3.8960299
7632	3.8826384	7692	3.8860393	7752	3.8894138	7812	3.8927622	7872	3.8960851
7633	3.8826953	7693	3.8860957	7753	3.8894698	7813	3.8928178	7873	3.8961402
7634	3.8827521	7694	3.8861522	7754	3.8895258	7814	3.8928734	7874	3.8961954
7635	3.8828090	7695	3.8862086	7755	3.8895818	7815	3.8929290	7875	3.8962506
7636	3.8828659	7696	3.8862650	7756	3.8896378	7816	3.8929845	7876	3.8963057
7637	3.8829228	7697	3.8863215	7757	3.8896938	7817	3.8930401	7877	3.8963608
7638	3.8829796	7698	3.8863779	7758	3.8897498	7818	3.8930957	7878	3.8964160
7639	3.8830365	7699	3.8864343	7759	3.8898057	7819	3.8931512	7879	3.8964711
7640	3.8830933	7700	3.8864907	7760	3.8898617	7820	3.8932067	7880	3.8965262
7641	3.8831502	7701	3.8865471	7761	3.8899177	7821	3.8932623	7881	3.8965813
7642	3.8832070	7702	3.8866035	7762	3.8899736	7822	3.8933178	7882	3.8966364
7643	3.8832638	7703	3.8866599	7763	3.8900296	7823	3.8933733	7883	3.8966915
7644	3.8833207	7704	3.8867163	7764	3.8900855	7824	3.8934288	7884	3.8967466
7645	3.8833775	7705	3.8867726	7765	3.8901415	7825	3.8934843	7885	3.8968017
7646	3.8834343	7706	3.8868290	7766	3.8901974	7826	3.8935398	7886	3.8968568
7647	3.8834 11	7707	3.8868853	7767	3.8902533	7827	3.8935953	7887	3.8969118
7648	3.8835479	7708	3.8869417	7768	3.8903092	7828	3.8936508	7888	3.8969669
7649	3.8836047	7709	3.8869980	7769	3.8903651	7829	3.8937063	7889	3.8970219
7650	3.8836614	7710	3.8870544	7770	3.8904210	7830	3.8937618	7890	3.8970770
7651	3.8837182	7711	3.8871107	7771	3.8904769	7831	3.8938172	7891	3.8971320
7652	3.8837750	7712	3.8871670	7772	3.8905328	7832	3.8938727	7892	3.8971871
7653	3.8838317	7713	3 8872233	7773	3.8905887	7833	3.8939281	7893	3.8972421
7654	3.8838884	7714	3.8872796	7774	3.8906445	7834	3.8939836	7894	3.8972971
7655	3.8839452	7715	3.8873359	7775	3.8907004	7835	3.8940390	7895	3.8973521
7656	3.8840019	7716	3.8873922	7776	3.8907562	7836	3.8940944	7896	3.8974071
7657	3.8840586	7717	3.8874485	7777	3.8908121	7837	3.8941498	7897	3.8974621
7658	3.8841154	7718	3.8875048	7778	3.8908679	7838	3.8942052	7898	3.8975171
7659	3.8841721	7719	3.8875610	7779	3.8909238	7839	3.8942607	7899	3.8975721
7660	3.8842288	7720	3.8876173	7780	3.8909756	7840	3.8943161	7900	3.8976271

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
7901	3.8976821	7961	3.9009576	8021	3.9042285	8081	3.9074651	8141	3.9106777
7902	3.8977370	7962	3.9010222	8022	3.9042826	8082	3.9075188	8142	3.9107311
7903	3.8977920	7963	3.9010767	8023	3.9043368	8083	3.9075726	8143	3.9107844
7904	3.8978469	7964	3.9011312	8024	3.9043909	8084	3.9076263	8144	3.9108378
7905	3.8979019	7965	3.9011857	8025	3.9044450	8085	3.9076800	8145	3.9108911
7906	3.8979568	7966	3.9012403	8026	3.9044991	8086	3.9077337	8146	3.9109444
7907	3.8980117	7967	3.9012948	8027	3.9045533	8087	3.9077874	8147	3.9109977
7908	3.8980667	7968	3.9013493	8028	3.9046074	8088	3.9078411	8148	3.9110510
7909	3.8981216	7969	3.9014038	8029	3.9046614	8089	3.9078948	8149	3.9111043
7910	3.8981765	7970	3.9014583	8030	3.9047155	8090	3.9079485	8150	3.9111576
7911	3.8982314	7971	3.9015128	8031	3.9047696	8091	3.9080022	8151	3.9112109
7912	3.8982863	7972	3.9015673	8032	3.9048237	8092	3.9080559	8152	3.9112642
7913	3.8983412	7973	3.9016218	8033	3.9048778	8093	3.9081095	8153	3.9113174
7914	3.8983960	7974	3.9016762	8034	3.9049318	8094	3.9081632	8154	3.9113707
7915	3.8984509	7975	3.9017307	8035	3.9049859	8095	3.9082168	8155	3.9114240
7916	3.8985058	7976	3.9017851	8036	3.9050400	8096	3.9082705	8156	3.9114772
7917	3.8985606	7977	3.9018396	8037	3.9050940	8097	3.9083241	8157	3.9115305
7918	3.8986155	7978	3.9018940	8038	3.9051480	8098	3.9083778	8158	3.9115837
7919	3.8986703	7979	3.9019485	8039	3.9052020	8099	3.9084314	8159	3.9116369
7920	3.8987252	7980	3.9020029	8040	3.9052560	8100	3.9084850	8160	3.9116901
7921	3.8987800	7981	3.9020573	8041	3.9053101	8101	3.9085386	8161	3.9117434
7922	3.8988348	7982	3.9021117	8042	3.9053641	8102	3.9085922	8162	3.9117966
7923	3.8988896	7983	3.9021661	8043	3.9054181	8103	3.9086458	8163	3.9118498
7924	3.8989445	7984	3.9022205	8044	3.9054721	8104	3.9086994	8164	3.9119030
7925	3.8989993	7985	3.9022749	8045	3.9055260	8105	3.9087530	8165	3.9119562
7926	3.8990541	7986	3.9023293	8046	3.9055800	8106	3.9088066	8166	3.9120094
7927	3.8991088	7987	3.9023837	8047	3.9056340	8107	3.9088602	8167	3.9120625
7928	3.8991636	7988	3.9024380	8048	3.9056880	8108	3.9089137	8168	3.9121157
7929	3.8992184	7989	3.9024924	8049	3.9057419	8109	3.9089673	8169	3.9121689
7930	3.8992732	7990	3.9025468	8050	3.9057959	8110	3.9090208	8170	3.9122220
7931	3.8993279	7991	3.9026011	8051	3.9058498	8111	3.9090744	8171	3.9122752
7932	3.8993827	7992	3.9026554	8052	3.9059038	8112	3.9091279	8172	3.9123233
7933	3.8994374	7993	3.9027098	8053	3.9059577	8113	3.9091815	8173	3.9123815
7934	3.8994922	7994	3.9027641	8054	3.9060116	8114	3.9092350	8174	3.9124346
7935	3.8995469	7995	3.9028185	8055	3.9060655	8115	3.9092885	8175	3.9124878
7936	3.8996016	7996	3.9028728	8056	3.9061194	8116	3.9093420	8176	3.9125409
7937	3.8996564	7997	3.9029271	8057	3.9061734	8117	3.9093955	8177	3.9125940
7938	3.8997111	7998	3.9029814	8058	3.9062273	8118	3.9094490	8178	3.9126471
7939	3.8997658	7999	3.9030357	8059	3.9062811	8119	3.9095025	8179	3.9127002
7940	3.8998205	8000	3.9030900	8060	3.9063350	8120	3.9095560	8180	3.9127533
7941	3.8998752	8001	3.9031443	8061	3.9063889	8121	3.9096095	8181	3.9128064
7942	3.8999299	8002	3.9031985	8062	3.9064428	8122	3.9096630	8182	3.9128595
7943	3.8999846	8003	3.9032528	8063	3.9064966	8123	3.9097164	8183	3.9129125
7944	3.9000392	8004	3.9033071	8064	3.9065505	8124	3.9097699	8184	3.9129656
7945	3.9000939	8005	3.9033613	8065	3.9066044	8125	3.9098234	8185	3.9130187
7946	3.9001486	8006	3.9034156	8066	3.9066582	8126	3.9098768	8186	3.9130717
7947	3.9002032	8007	3.9034698	8067	3.9067120	8127	3.9099302	8187	3.9131248
7948	3.9002578	8008	3.9035241	8068	3.9067659	8128	3.9099837	8188	3.9131778
7949	3.9003125	8009	3.9035783	8069	3.9068197	8129	3.9100371	8189	3.9132309
7950	3.9003671	8010	3.9036325	8070	3.9068735	8130	3.9100905	8190	3.9132839
7951	3.9004217	8011	3.9036867	8071	3.9069273	8131	3.9101440	8191	3.9133369
7952	3.9004764	8012	3.9037409	8072	3.9069811	8132	3.9101974	8192	3.9133899
7953	3.9005310	8013	3.9037951	8073	3.9070349	8133	3.9102508	8193	3.9134429
7954	3.9005856	8014	3.9038493	8074	3.9070887	8134	3.9103042	8194	3.9134959
7955	3.9006402	8015	3.9039035	8075	3.9071425	8135	3.9103575	8195	3.9135489
7956	3.9006948	8016	3.9039577	8076	3.9071963	8136	3.9104109	8196	3.9136019
7957	3.9007493	8017	3.9040119	8077	3.9072501	8137	3.9104643	8197	3.9136549
7958	3.9008039	8018	3.9040660	8078	3.9073038	8138	3.9105177	8198	3.9137079
7959	3.9008585	8019	3.9041202	8079	3.9073576	8139	3.9105710	8199	3.9137609
7960	3.9009131	8020	3.9041744	8080	3.9074114	8140	3.9106244	8200	3.9138138

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
8201	3.9138668	8261	3.9170326	8321	3.9201755	8381	3.9232958	8441	3.9263939
8202	3.9139198	8262	3.9170852	8322	3.9202277	8382	3.9233476	8442	3.9264453
8203	3.9139727	8263	3.9171377	8323	3.9202799	8383	3.9233995	8443	3.9264968
8204	3.9140256	8264	3.9171903	8324	3.9203321	8384	3.9234513	8444	3.9265482
8205	3.9140786	8265	3.9172428	8325	3.9203842	8385	3.9235031	8445	3.9265996
8206	3.9141315	8266	3.9172954	8326	39204364	8386	3.9235548	8446	3.9266511
8207	3.9141844	8267	3.9173479	8327	3.9204886	8387	3.9236066	8447	3.9267025
8208	3.9142373	8268	3.9174005	8328	3.9205407	8388	3.9236584	8448	3.9267539
8209	3.9142902	8269	3.9174530	8329	3.9205929	8389	3.9237102	8449	3.9268053
8210	3.9143431	8270	3.9175055	8330	3.9206450	8390	3.9237620	8450	3.9268567
8211	3.9143960	8271	3.9175580	8331	3.9206971	8391	3.9238137	8451	3.9269081
8212	3.9144489	8272	3.9176105	8332	3.9207493	8392	3.9238655	8452	3.9269595
8213	3.9145018	8273	3.9176630	8333	3.9208014	8393	3.9239172	8453	3.9270109
8214	3.9145547	8274	3.9177155	8334	3.9208535	8394	3.9239690	8454	3.9270622
8215	3.9146076	8275	3.9177680	8335	3.9209056	8395	3.9240207	8455	3.9271136
8216	3.9146604	8276	3.9178205	8336	3.9209577	8396	3.9240724	8456	3.9271650
8217	3.9147133	8277	3.9178729	8337	3.9210098	8397	3.9241241	8457	3.9272163
8218	3.9147661	8278	3.9179254	8338	3.9210619	8398	3.9241759	8458	3.9272677
8219	3.9148190	8279	3.9179779	8339	3.9211140	8399	3.9242276	8459	3.9273150
8220	3.9148718	8280	3.9180303	8340	3.9211660	8400	3.9242793	8460	3.9273704
8221	3.9149246	8281	3.9180828	8341	3.9212181	8401	3.9243310	8461	3.9274217
8222	3.9149775	8282	3.9181352	8342	3.9212702	8402	3.9243827	8462	3.9274730
8223	3.9150303	8283	3.9181877	8343	3.9213222	8403	3.9244344	8463	3.9275243
8224	3.9150831	8284	3.9182401	8344	3.9213743	8404	3.9244860	8464	3.9275756
8225	3.9151359	8285	3.9182925	8345	3.9214263	8405	3.9245377	8465	3.9276270
8226	3.9151887	8286	3.9183449	8346	3.9214784	8405	3.9245894	8466	3.9276783
8227	3.9152415	8287	3.9183973	8347	3.9215304	8407	3.9246410	8467	3.9277295
8228	3.9152943	8288	3.9184497	8348	3.9215824	8408	3.9246927	8468	3.9277808
8229	3.9153471	8289	3.9185021	8349	3.9216345	8409	3.9247443	8469	3.9278321
8230	3.9153998	8290	3.9185545	8350	3.9216865	8410	3.9247960	8470	3.9278834
8231	3.9154526	8291	3.9186069	8351	3.9217385	8411	3.9248476	8471	3.9279347
8232	3.9155054	8292	3.9186593	8352	3.9217905	8412	3.9248993	8472	3.9279859
8233	3.9155581	8293	3.9187117	8353	3.9218425	8413	3.9249509	8473	3.9280372
8234	3.9156109	8294	3.9187640	8354	3.9218945	8414	3.9250025	8474	3.9280884
8235	3.9156636	8295	3.9188164	8355	3.9219464	8415	3.9250541	8475	3.9281397
8236	3.9157163	8296	3.9188687	8356	3.9219984	8416	3.9251057	8476	3.9281909
8237	3.9157691	8297	3.9189211	8357	3.9220504	8417	3.9251573	8477	3.9282422
8238	3.9158218	8298	3.9189734	8358	3.9221024	8418	3.9252089	8478	3.9282934
8239	3.9158745	8299	3.9190258	8359	3.9221543	8419	3.9252605	8479	3.9283446
8240	3.9159272	8300	3.9190781	8360	3.9222063	8420	3.9253121	8480	3.9283958
8241	3.9159799	8301	3.9191304	8361	3.9222582	8421	3.9253637	8481	3.9284471
8242	3.9169326	8302	3.9191827	8362	3.9223102	8422	3.9254152	8482	3.9284983
8243	3.9160853	8303	3.9192350	8363	3.9223621	8423	3.9254668	8483	3.9285495
8244	3.9161380	8304	3.9192873	8364	3.9224140	8424	3.9255183	8484	3.9286006
8245	3.9161907	8305	3.9193396	8365	3.9224659	8425	3.9255699	8485	3.9286518
8246	3.9162433	8306	3.9193919	8366	3.9225179	8426	3.9256214	8486	3.9287030
8247	3.9162960	8307	3.9194442	8367	3.9225698	8427	3.9256730	8487	3.9287542
8248	3.9163486	8308	3.9194965	8368	3.9226217	8428	3.9257245	8488	3.9288054
8249	3.9164013	8309	3.9195487	8369	3.9226736	8429	3.9257760	8489	3.9288565
8250	3.9164539	8310	3.9196010	8370	3.9227254	8430	3.9258276	8490	3.9289077
8251	3.9165066	8311	3.9196533	8371	3.9227773	8431	3.9258791	8491	3.9289588
8252	3.9165592	8312	3.9197055	8372	3.9228292	8432	3.9259306	8492	3.9290100
8253	3.9166118	8313	3.9197578	8373	3.9228811	8433	3.9259821	8493	3.9290611
8254	3.9166645	8314	3.9198100	8374	3.9229329	8434	3.9260336	8494	3.9291122
8255	3.9167171	8315	3.9198622	8375	3.9229848	8435	3.9260851	8495	3.9291634
8256	3.9167697	8316	3.9199145	8376	3.9230367	8436	3.9261366	8496	3.9292145
8257	3.9168223	8317	3.9199667	8377	3.9230885	8437	3.9261880	8497	3.9292656
8258	3.9168749	8318	3.9200189	8378	3.9231403	8438	3.9262395	8498	3.9293167
8259	3.9169275	8319	3.9200711	8379	3.9231922	8439	3.9262910	8499	3.9293678
8260	3.9169800	8320	3.9201233	8380	3.9232440	8440	3.9263424	8500	3.9294189

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
8501	3.9294700	8561	3.9325245	8621	3.9355576	8681	3.9385697	8741	3.9415611
8502	3.9295211	8562	3.9325752	8622	3.9356080	8682	3.9386198	8742	3.9416108
8503	3.9295722	8563	3.9326259	8623	3.9356584	8683	3.9386698	8743	3.9416605
8504	3.9296232	8564	3.9326765	8624	3.9357087	8684	3.9387198	8744	3.9417101
8505	3.9296743	8565	3.9327274	8625	3.9357591	8685	3.9387698	8745	3.9417598
8506	3.9297254	8566	3.9327781	8626	3.9358094	8686	3.9388198	8746	3.9418095
8507	3.9297764	8567	3.9328288	8627	3.9358598	8687	3.9388698	8747	3.9418591
8508	3.9298275	8568	3.9328794	8628	3.9359101	8688	3.9389193	8748	3.9419088
8509	3.9298785	8569	3.9329301	8629	3.9359605	8689	3.9389598	8749	3.9419584
8510	3.9299296	8570	3.9329808	8630	3.9360108	8690	3.9390198	8750	3.9420080
8511	3.9299806	8571	3.9330315	8631	3.9360611	8691	3.9390697	8751	3.9420577
8512	3.9300316	8572	3.9330822	8632	3.9361114	8692	3.9391197	8752	3.9421073
8513	3.9300826	8573	3.9331328	8633	3.9361617	8693	3.9391697	8753	3.9421569
8514	3.9301336	8574	3.9331835	8634	3.9362120	8694	3.9392196	8754	3.9422065
8515	3.9301845	8575	3.9332341	8635	3.9362623	8695	3.9392696	8755	3.9422561
8516	3.9302356	8576	3.9332848	8636	3.9363126	8696	3.9393195	8756	3.9423057
8517	3.9302866	8577	3.9333354	8637	3.9363629	8697	3.9393695	8757	3.9423553
8518	3.9303376	8578	3.9333860	8638	3.9364132	8698	3.9394194	8758	3.9424049
8519	3.9303886	8579	3.9334367	8639	3.9364635	8699	3.9394693	8759	3.9424545
8520	3.9304396	8580	3.9334873	8640	3.9365137	8700	3.9395192	8760	3.9425041
8521	3 9304906	8581	3.9335379	8641	3.9365640	8701	3.9395692	8761	3.9425537
8522	3.9305415	8582	3.9335885	8642	3.9366143	8702	3.9396191	8762	3.9426032
8523	3.9305925	8583	3.9336391	8643	3.9366645	8703	3.9396690	8763	3.9426528
8524	3.9306434	8584	3.9336897	8644	3.9367147	8704	3.9397189	8764	3.9427024
8525	3.9306944	8585	3.9337403	8645	3.9367650	8705	3.9397688	8765	3.9427519
8526	3.9307453	8586	3.9337909	8646	3.9368152	8706	3.9398187	8766	3.9428015
8527	3.9307963	8587	3.9338415	8647	3.9368654	8707	3.9398685	8767	3.9428510
8528	3.9308472	8588	3.9338920	8648	3.9369157	8708	3.9399184	8768	3.9429005
8529	3.9308981	8589	3.9339426	8649	3.9369659	8709	3.9399683	8769	3.9429501
8530	3.9309490	8590	3.9339932	8650	3.9370161	8710	3.9400181	8770	3.9429996
8531	3.9309999	8591	3.9340437	8651	3.9370663	8711	3.9400680	8771	3.9430491
8532	3.9310508	8592	3.9340943	8652	3.9371165	8712	3.9401179	8772	3.9430986
8533	3.9311017	8593	3.9341448	8653	3.9371667	8713	3.9401677	8773	3.9431481
8534	3.9311526	8594	3.9341953	8654	3.9372169	8714	3.9402175	8774	3.9431976
8535	3.9312035	8595	3.9342459	8655	3.9372671	8715	3.9402674	8775	3.9432471
8536	3.9312544	8596	3.9342964	8656	3.9373172	8716	3.9403172	8776	3.9432966
8537	3.9313053	8597	3.9343469	8657	3.9373674	8717	3.9403670	8777	3.9433461
8538	3.9313561	8598	3.9343974	8658	3.9374176	8718	3.9404169	8778	3.9433956
8539	3.9314070	8599	3.9344479	8659	3.9374677	8719	3.9404667	8779	3.9434450
8540	3.9314579	8600	3.9344984	8660	3.9375179	8720	3.9405165	8780	3.9434945
8541	3.9315087	8601	3.9345489	8661	3.9375680	8721	3.9405663	8781	3.9435440
8542	3.9315596	8602	3.9345994	8662	3.9376182	8722	3.9406161	8782	3.9435934
8543	3.9316104	8603	3.9346499	8663	3.9376683	8723	3.9406659	8783	3.9436429
8544	3.9316612	8604	3.9347004	8664	3.9377184	8724	3.9407156	8784	3.9436923
8545	3.9317121	8605	3.9347509	8665	3.9377686	8725	3.9407654	8785	3.9437418
8546	3.9317629	8606	3.9348013	8666	3.9378187	8726	3.9408152	8786	3.9437912
8547	3.9318137	8607	3.9348518	8667	3.9378688	8727	3.9408650	8787	3.9438406
8548	3.9318645	8608	3.9349022	8668	3.9379189	8728	3.9409147	8788	3.9438900
8549	3.9319153	8609	3.9349527	8669	3.9379690	8729	3.9409645	8789	3.9439395
8550	3.9319661	8610	3.9350031	8670	3.9380191	8730	3.9410142	8790	3.9439889
8551	3.9320169	8611	3.9350536	8671	3.9380692	8731	3.9410640	8791	3.9440383
8552	3.9320677	8612	3.9351040	8672	3.9381193	8732	3.9411137	8792	3.9440871
8553	3.9321185	8613	3.9351544	8673	3.9381693	8733	3.9411635	8793	3.9441377
8554	3.9321692	8614	3.9352049	8674	3.9382194	8734	3.9412132	8794	3.9441865
8555	3.9322200	8615	3.9352553	8675	3.9382695	8735	3.9412629	8795	3.9442358
8556	3.9322708	8616	3.9353057	8676	3.9383195	8736	3.9413126	8796	3.9442852
8557	3.9323215	8617	3.9353561	8677	3.9383696	8737	3.9413623	8797	3.9443346
8558	3.9323723	8618	3.9354065	8678	3.9384196	8738	3.9414120	8798	3 9443839
8559	3.9324230	8619	3.9354569	8679	3.9384697	8739	3.9414617	8799	3.9444333
8560	3.9324738	8620	3.9355073	8680	3.9385197	8740	3.9415114	8800	3.9444827

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
8801	3.9445320	8861	3.9474827	8921	3.9504135	8981	3.9533247	9041	3.9562165
8802	3.9445814	8862	3.9475317	8922	3.9504622	8982	3.9533730	9042	3.9562645
8803	3.9446307	8863	3.9475807	8923	3.9505109	8983	3.9534214	9043	3.9563125
8804	3.9446800	8864	3.9476297	8924	3.9505596	8984	3.9534697	9044	3.9563605
8805	3.9447294	8865	3.9476787	8925	3.9506082	8985	3.9535181	9045	3.9564086
8806	3.9447787	8866	3.9477277	8926	3.9506569	8986	3.9535664	9046	3.9564566
8807	3.9448280	8867	3.9477767	8927	3.9507055	8987	3.9536147	9047	3.9565046
8808	3.9448773	8868	3.9478257	8928	3.9507542	8988	3.9536631	9048	3.9565526
8809	3.9449266	8869	3.9478746	8929	3.9508028	8989	3.9537114	9049	3.9566006
8810	3.9449759	8870	3.9479236	8930	3.9508514	8990	3.9537597	9050	3.9566486
8811	3.9450252	8871	3.9479726	8931	3.9509001	8991	3.9538080	9051	3.9566966
8812	3.9450745	8872	3.9480215	8932	3.9509487	8992	3.9538563	9052	3.9567445
8813	3.9451238	8873	3.9480705	8933	3.9509973	8993	3.9539046	9053	3.9567925
8814	3.9451730	8874	3.9481194	8934	3.9510459	8994	3.9539529	9054	3.9568405
8815	3.9452223	8875	3.9481684	8935	3.9510945	8995	3.9540012	9055	3.9568884
8816	3.9452716	8876	3.9482173	8936	3.9511432	8996	3.9540494	9056	3.9569364
8817	3.9453208	8877	3.9482662	8937	3.9511917	8997	3.9540977	9057	3.9569844
8818	3.9453701	8878	3.9483151	8938	3.9512403	8998	3.9541460	9058	3.9570323
8819	3.9454193	8879	3.9483640	8939	3.9512889	8999	3.9541942	9059	3.9570802
8820	3.9454686	8880	3.9484130	8940	3.9513375	9000	3.9542425	9060	3.9571282
8821	3.9455178	8881	3.9484619	8941	3.9513861	9001	3.9542908	9061	3.9571761
8822	3.9455670	8882	3.9485108	8942	3.9514347	9002	3.9543390	9062	3.9572240
8823	3.9456163	8883	3.9485597	8943	3.9514832	9003	3.9543872	9063	3.9572720
8824	3.9456655	8884	3.9486045	8944	3.9515318	9004	3.9544355	9064	3.9573199
8825	3.9457147	8885	3.9486574	8945	3.9515803	9005	3.9544837	9065	3.9573678
8826	3.9457639	8886	3.9487063	8946	3.9516289	9006	3.9545319	9066	3.9574157
8827	3.9458131	8887	3.9487552	8947	3.9516774	9007	3.9545802	9067	3.9574636
8828	3.9458623	8888	3.9488040	8948	3.9517260	9008	3.9546284	9068	3.9575115
8829	3.9459115	8889	3.9488529	8949	3.9517745	9009	3.9546766	9069	3.9575594
8830	3.9459607	8890	3.9489018	8950	3.9518230	9010	3.9547248	9070	3.9576073
8831	3.9460099	8891	3.9489506	8951	3.9518715	9011	3.9547730	9071	3.9576552
8832	3.9460591	8892	3.9489994	8952	3.9519201	9012	3.9548212	9072	3.9577030
8833	3.9461082	8893	3.9490483	8953	3.9519686	9013	3.9548694	9073	3.9577509
8834	3.9461574	8894	3.9490971	8954	3.9520171	9014	3.9549175	9074	3.9577988
8835	3.9462065	8895	3.9491459	8955	3.9520656	9015	3.9549657	9075	3.9578466
8836	3.9462557	8896	3.9491948	8956	3.9521141	9016	3.9550139	9076	3.9578945
8837	3.9463048	8897	3.9492436	8957	3.9521626	9017	3.9550621	9077	3.9579423
8838	3.9463540	8898	3.9492924	8958	3.9522110	9018	3.9551102	9078	3.9579902
8839	3.9464031	8899	3.9493412	8959	3.9522595	9019	3.9551584	9079	3.9580380
8840	3.9464523	8900	3.9493900	8960	3.9523080	9020	3.9552065	9080	3.9580858
8841	3.9465014	8901	3.9494388	8961	3.9523565	9021	3.9552547	9081	3.9581337
8842	3.9465505	8902	3.9494876	8962	3.9524049	9022	3.9553028	9082	3.9581815
8843	3.9465996	8903	3.9495364	8963	3.9524534	9023	3.9553509	9083	3.9582293
8844	3.9466487	8904	3.9495851	8964	3.9525018	9024	3.9553991	9084	3.9582771
8845	3.9466978	8905	3.9496339	8965	3.9525503	9025	3.9554472	9085	3.9583249
8846	3.9467469	8906	3.9496827	8966	3.9525987	9026	3.9554953	9086	3.9583727
8847	3.9467960	8907	3.9497314	8967	3.9526472	9027	3.9555434	9087	3.9584205
8848	3.9468451	8908	3.9497802	8968	3.9526956	9028	3.9555915	9088	3.9584683
8849	3.9468942	8909	3.9498289	8969	3.9527440	9029	3.9556396	9089	3.9585161
8850	3.9469433	8910	3.9498777	8970	3.9527924	9030	3.9556877	9090	3.9585639
8851	3.9469923	8911	3.9499264	8971	3.9528408	9031	3.9557358	9091	3.9586116
8852	3.9470414	8912	3.9499752	8972	3.9528893	9032	3.9557839	9092	3.9586594
8853	3.9470905	8913	3.9500239	8973	3.9529377	9033	3.9558320	9093	3.9587072
8854	3.9471395	8914	3.9500726	8974	3.9529861	9034	3.9558801	9094	3.9587549
8855	3.9471886	8915	3.9501213	8975	3.9530344	9035	3.9559281	9095	3.9588027
8856	3.9472376	8916	3.9501700	8976	3.9530828	9036	3.9559762	9096	3.9588504
8857	3.9472866	8917	3.9502188	8977	3.9531312	9037	3.9560243	9097	3.9588982
8858	3.9473357	8918	3.9502675	8978	3.9531796	9038	3.9560723	9098	3.9589459
8859	3.9473847	8919	3.9503162	8979	3.9532280	9039	3.9561204	9099	3.9589937
8860	3.9474337	8920	3.9503648	8980	3.9532763	9040	3.9561684	9100	3.9590414

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
9101	3.9590891	9161	3.9619429	9221	3.9647780	9281	3.9675948	9341	3.9703934
9102	3.9591368	9162	3.9619903	9222	3.9648251	9282	3.9676415	9342	3.9704399
9103	3.9591845	9163	3.9620377	9223	3.9648722	9283	3.9676883	9343	3.9704863
9104	3.9592322	9164	3.9620851	9224	3.9649193	9284	3.9677351	9344	3.9705328
9105	3.9592799	9165	3.9621325	9225	3.9649664	9285	3.9677819	9345	3.9705793
9106	3.9593276	9166	3.9621798	9226	3.9650134	9286	3.9678287	9346	3.9706258
9107	3.9593753	9167	3.9622272	9227	3.9650605	9287	3.9678754	9347	3.9706722
9108	3.9594230	9168	3.9622746	9228	3.9651076	9288	3.9679222	9348	3.9707187
9109	3.9594707	9169	3.9623220	9229	3.9651546	9289	3.9679690	9349	3.9707651
9110	3.9595184	9170	3.9623693	9230	3.9652017	9290	3.9680157	9350	3.9708116
9111	3.9595660	9171	3.9624167	9231	3.9652487	9291	3.9680625	9351	3.9708580
9112	3.9596137	9172	3.9624640	9232	3.9652958	9292	3.9681092	9352	3.9709045
9113	3.9596614	9173	3.9625114	9233	3.9653428	9293	3.9681559	9353	3.9709509
9114	3.9597090	9174	3.9625587	9234	3.9653899	9294	3.9682027	9354	3.9709974
9115	3.9597567	9175	3.9626061	9235	3.9654369	9295	3.9682494	9355	3.9710438
9116	3.9598043	9176	3.9626534	9236	3.9654839	9296	3.9682961	9356	3.9710902
9117	3.9598519	9177	3.9627007	9237	3.9655309	9297	3.9683428	9357	3.9711366
9118	3.9598996	9178	3.9627480	9238	3.9655779	9298	3.9683895	9358	3.9711830
9119	3.9599472	9179	3.9627954	9239	3.9656250	9299	3.9684362	9359	3.9712294
9120	3.9599948	9180	3.9628427	9240	3.9656720	9300	3.9684829	9360	3.9712758
9121	3.9600424	9181	3.9628900	9241	3.9657190	9301	3.9685296	9361	3.9713222
9122	3.9600901	9182	3.9629373	9242	3.9657660	9302	3.9685763	9362	3.9713686
9123	3.9601377	9183	3.9629846	9243	3.9658129	9303	3.9686230	9363	3.9714150
9124	3.9601853	9184	3.9630319	9244	3.9658599	9304	3.9686697	9364	3.9714614
9125	3.9602329	9185	3.9630792	9245	3.9659069	9305	3.9687164	9365	3.9715078
9126	3.9602805	9186	3.9631264	9246	3.9659539	9306	3.9687630	9366	3.9715541
9127	3.9603280	9187	3.9631737	9247	3.9660008	9307	3.9688097	9367	3.9716005
9128	3.9603756	9188	3.9632210	9248	3.9660478	9308	3.9688564	9368	3.9716469
9129	3.9604232	9189	3.9632682	9249	3.9660948	9309	3.9689030	9369	3.9716932
9130	3.9604708	9190	3.9633155	9250	3.9661417	9310	3.9689497	9370	3.9717396
9131	3.9605183	9191	3.9633628	9251	3.9661887	9311	3.9689963	9371	3.9717859
9132	3.9605659	9192	3.9634100	9252	3.9662356	9312	3.9690430	9372	3.9718323
9133	3.9606134	9193	3.9634573	9253	3.9662826	9313	3.9690896	9373	3.9718786
9134	3.9606610	9194	3.9635045	9254	3.9663295	9314	3.9691362	9374	3.9719249
9135	3.9607085	9195	3.9635517	9255	3.9663764	9315	3.9691828	9375	3.9719713
9136	3.9607561	9196	3.9635990	9256	3.9664233	9316	3.9692295	9376	3.9720176
9137	3.9608036	9197	3.9636462	9257	3.9664703	9317	3.9692761	9377	3.9720639
9138	3.9608511	9198	3.9636934	9258	3.9665172	9318	3.9693227	9378	3.9721102
9139	3.9608987	9199	3.9637406	9259	3.9665641	9319	3.9693693	9379	3.9721565
9140	3.9609462	9200	3.9637878	9260	3.9666110	9320	3.9694159	9380	3.9722028
9141	3.9609937	9201	3.9638350	9261	3.9666579	9321	3.9694625	9381	3.9722491
9142	3.9610412	9202	3.9638822	9262	3.9667048	9322	3.9695091	9382	3.9722954
9143	3.9610887	9203	3.9639294	9263	3.9667517	9323	3.9695557	9383	3.9723417
9144	3.9611362	9204	3.9639766	9264	3.9667985	9324	3.9696023	9384	3.9723880
9145	3.9611837	9205	3.9640238	9265	3.9668454	9325	3.9696488	9385	3.9724342
9146	3.9612312	9206	3.9640710	9266	3.9668923	9326	3.9696954	9386	3.9724805
9147	3.9612787	9207	3.9641181	9267	3.9669392	9327	3.9697420	9387	3.9725268
9148	3.9613261	9208	3.9641653	9268	3.9669860	9328	3.9697885	9388	3.9725731
9149	3.9613736	9209	3.9642125	9269	3.9670329	9329	3.9698351	9389	3.9726193
9150	3.9614211	9210	3.9642596	9270	3.9670797	9330	3.9698816	9390	3.9726656
9151	3.9614685	9211	3.9643068	9271	3.9671266	9331	3.9699282	9391	3.9727118
9152	3.9615160	9212	3.9643539	9272	3.9671734	9332	3.9699747	9392	3.9727581
9153	3.9615635	9213	3.9644011	9273	3.9672202	9333	3.9700213	9393	3.9728043
9154	3.9616109	9214	3.9644482	9274	3.9672671	9334	3.9700678	9394	3.9728505
9155	3.9616583	9215	3.9644953	9275	3.9673139	9335	3.9701143	9395	3.9728968
9156	3.9617058	9216	3.9645425	9276	3.9673607	9336	3.9701608	9396	3.9729430
9157	3.9617532	9217	3.9645896	9277	3.9674075	9337	3.9702073	9397	3.9729892
9158	3.9618006	9218	3.9646367	9278	3.9674544	9338	3.9702539	9398	3.9730354
9159	3.9618480	9219	3.9646838	9279	3.9675012	9339	3.9703004	9399	3.9730816
9160	3.9618955	9220	3.9647309	9280	3.9675480	9340	3.9703469	9400	3.9731278

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
9401	3.9731740	9461	3.9759370	9521	3.9786826	9581	3.9814108	9641	3.9841221
9402	3.9732202	9462	3.9759829	9522	3.9787282	9582	3.9814562	9642	3.9841671
9403	3.9732664	9463	3.9760288	9523	3.9787738	9583	3.9815015	9643	3.9842122
9404	3.9733126	9464	3.9760747	9524	3.9788194	9584	3.9815468	9644	3.9842572
9405	3.9733588	9465	3.9761206	9525	3.9788650	9585	3.9815921	9645	3.9843022
9406	3.9734050	9466	3.9761665	9526	3.9789106	9586	3.9816374	9646	3.9843472
9407	3.9734511	9467	3.9762124	9527	3.9789562	9587	3.9816827	9647	3.9843923
9408	3.9734973	9468	3.9762582	9528	3.9790017	9588	3.9817280	9648	3.9844373
9409	3.9735435	9469	3.9763041	9529	3.9790473	9589	3.9817733	9649	3.9844823
9410	3.9735896	9470	3.9763500	9530	3.9790929	9590	3.9818186	9650	3.9845273
9411	3.9736358	9471	3.9763958	9531	3.9791385	9591	3.9818639	9651	3.9845723
9412	3.9736819	9472	3.9764417	9532	3.9791840	9592	3.9819092	9652	3.9846173
9413	3.9737280	9473	3.9764875	9533	3.9792296	9593	3.9819544	9653	3.9846623
9414	3.9737742	9474	3.9765334	9534	3.9792751	9594	3.9819997	9654	3.9847073
9415	3.9738203	9475	3.9765792	9535	3.9793207	9595	3.9820450	9655	3.9847523
9416	3.9738664	9476	3.9766250	9536	3.9793662	9596	3.9820902	9656	3.9847972
9417	3.9739126	9477	3.9766709	9537	3.9794118	9597	3.9821355	9657	3.9848422
9418	3.9739587	9478	3.9767167	9538	3.9794573	9598	3.9821807	9658	3.9848872
9419	3.9740048	9479	3.9767625	9539	3.9795028	9599	3.9822260	9659	3.9849322
9420	3.9740509	9480	3.9768083	9540	3.9795484	9600	3.9822712	9660	3.9849771
9421	3.9740970	9481	3.9768541	9541	3.9795939	9601	3.9823165	9661	3.9850221
9422	3.9741431	9482	3.9768999	9542	3.9796394	9602	3.9823617	9662	3.9850670
9423	3.9741892	9483	3.9769457	9543	3.9796849	9603	3.9824069	9663	3.9851120
9424	3.9742353	9484	3.9769915	9544	3.9797304	9604	3.9824521	9664	3.9851569
9425	3.9742813	9485	3.9770373	9545	3.9797759	9605	3.9824974	9665	3.9852018
9426	3.9743274	9486	3.9770831	9546	3.9798214	9606	3.9825426	9666	3.9852468
9427	3.9743735	9487	3.9771289	9547	3.9798669	9607	3.9825878	9667	3.9852917
9428	3.9744196	9488	3.9771747	9548	3.9799124	9608	3.9826330	9668	3.9853366
9429	3.9744656	9489	3.9772204	9549	3.9799579	9609	3.9826782	9669	3.9853816
9430	3.9745117	9490	3.9772662	9550	3.9800034	9610	3.9827234	9670	3.9854265
9431	3.9745577	9491	3.9773120	9551	3.9800488	9611	3.9827686	9671	3.9854714
9432	3.9746038	9492	3.9773577	9552	3.9800943	9612	3.9828138	9672	3.9855163
9433	3.9746498	9493	3.9774035	9553	3.9801398	9613	3.9828589	9673	3.9855612
9434	3.9746959	9494	3.9774492	9554	3.9801852	9614	3.9829041	9674	3.9856061
9435	3.9747419	9495	3.9774950	9555	3.9802307	9615	3.9829493	9675	3.9856510
9436	3.9747879	9496	3.9775407	9556	3.9802761	9616	3.9829944	9676	3.9856958
9437	3.9748339	9497	3.9775864	9557	3.9803216	9617	3.9830396	9677	3.9857407
9438	3.9748800	9498	3.9776322	9558	3.9803670	9618	3.9830848	9678	3.9857856
9439	3.9749260	9499	3.9776779	9559	3.9804125	9619	3.9831299	9679	3.9858305
9440	3.9749720	9500	3.9777236	9560	3.9804579	9620	3.9831751	9680	3.9858753
9441	3.9750180	9501	3.9777693	9561	3.9805033	9621	3.9832202	9681	3.9859202
9442	3.9750640	9502	3.9778150	9562	3.9805487	9622	3.9832653	9682	3.9859651
9443	3.9751100	9503	3.9778607	9563	3.9805941	9623	3.9833105	9683	3.9860099
9444	3.9751560	9504	3.9779064	9564	3.9806396	9624	3.9833556	9684	3.9860548
9445	3.9752020	9505	3.9779521	9565	3.9806850	9625	3.9834007	9685	3.9860996
9446	3.9752479	9506	3.9779978	9566	3.9807304	9626	3.9834458	9686	3.9861445
9447	3.9752939	9507	3.9780435	9567	3.9807758	9627	3.9834910	9687	3.9861893
9448	3.9753399	9508	3.9780892	9568	3.9808212	9628	3.9835361	9688	3.9862341
9449	3.9753858	9509	3.9781348	9569	3.9808665	9629	3.9835812	9689	3.9862789
9450	3.9754318	9510	3.9781805	9570	3.9809119	9630	3.9836263	9690	3.9863238
9451	3.9754778	9511	3.9782262	9571	3.9809573	9631	3.9836714	9691	3.9863686
9452	3.9755237	9512	3.9782718	9572	3.9810027	9632	3.9837165	9692	3.9864134
9453	3.9755696	9513	3.9783175	9573	3.9810480	9633	3.9837616	9693	3.9864582
9454	3.9756156	9514	3.9783631	9574	3.9810934	9634	3.9838066	9694	3.9865030
9455	3.9756615	9515	3.9784088	9575	3.9811388	9635	3.9838517	9695	3.9865478
9456	3.9757075	9516	3.9784544	9576	3.9811841	9636	3.9838968	9696	3.9865926
9457	3.9757534	9517	3.9785001	9577	3.9812295	9637	3.9839418	9697	3.9866374
9458	3.9757993	9518	3.9785457	9578	3.9812748	9638	3.9839869	9698	3.9866822
9459	3.9758452	9519	3.9785913	9579	3.9813202	9639	3.9840320	9699	3.9867269
9460	3.9758911	9520	3.9786369	9580	3.9813655	9640	3.9840770	9700	3.9867717

Ten Chiliads of LOGARITHMS.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
9701	3.9868165	9761	3.9894943	9821	3.9921557	9881	3.9943009	9941	3.9974301
9702	3.9868613	9762	3.9895388	9822	3.9922000	9882	3.9948448	9942	3.9974437
9703	3.9869060	9763	3.9895833	9823	3.9922441	9883	3.9948888	9943	3.9975174
9704	3.9869508	9764	3.9896278	9824	3.9922883	9884	3.9949327	9944	3.9975611
9705	3.9869955	9765	3.9896722	9825	3.9923325	9885	3.9949767	9945	3.9976048
9706	3.9870403	9766	3.9897167	9826	3.9923767	9886	3.9950206	9946	3.9976484
9707	3.9870850	9767	3.9897612	9827	3.9924209	9887	3.9950645	9947	3.9976921
9708	3.9871298	9768	3.9898056	9828	3.9924651	9888	3.9951084	9948	3.9977358
9709	3.9871745	9769	3.9898501	9829	3.9925093	9889	3.9951524	9949	3.9977794
9710	3.9872192	9770	3.9898946	9830	3.9925535	9890	3.9951963	9950	3.9978231
9711	3.9872639	9771	3.9899390	9831	3.9925977	9891	3.9952402	9951	3.9978667
9712	3.9873087	9772	3.9899834	9832	3.9926419	9892	3.9952841	9952	3.9979104
9713	3.9873534	9773	3.9900276	9833	3.9926860	9893	3.9953280	9953	3.9979540
9714	3.9873981	9774	3.9900723	9834	3.9927302	9894	3.9953719	9954	3.9979976
9715	3.9874428	9775	3.9901168	9835	3.9927744	9895	3.9954158	9955	3.9980413
9716	3.9874875	9776	3.9901612	9836	3.9928185	9896	3.9954597	9956	3.9980849
9717	3.9875322	9777	3.9902056	9837	3.9928627	9897	3.9955036	9957	3.9981285
9718	3.9875769	9778	3.9902500	9838	3.9929068	9898	3.9955474	9958	3.9981721
9719	3.9876216	9779	3.9902944	9839	3.9929510	9899	3.9955913	9959	3.9982157
9720	3.9876663	9780	3.9903388	9840	3.9929951	9900	3.9956352	9960	3.9982593
9721	3.9877109	9781	3.9903832	9841	3.9930392	9901	3.9956791	9961	3.9983029
9722	3.9877556	9782	3.9904276	9842	3.9930834	9902	3.9957229	9962	3.9983465
9723	3.9878003	9783	3.9904720	9843	3.9931275	9903	3.9957668	9963	3.9983901
9724	3.9878449	9784	3.9905164	9844	3.9931716	9904	3.9958106	9964	3.9984337
9725	3.9878896	9785	3.9905608	9845	3.9932157	9905	3.9958545	9965	3.9984773
9726	3.9879343	9786	3.9906052	9846	3.9932598	9906	3.9958983	9966	3.9985209
9727	3.9879789	9787	3.9906496	9847	3.9933039	9907	3.9959422	9967	3.9985644
9728	3.9880236	9788	3.9906940	9848	3.9933480	9908	3.9959860	9968	3.9986080
9729	3.9880682	9789	3.9907383	9849	3.9933921	9909	3.9960298	9969	3.9986516
9730	3.9881128	9790	3.9907827	9850	3.9934362	9910	3.9960736	9970	3.9986951
9731	3.9881575	9791	3.9908270	9851	3.9934803	9911	3.9961175	9971	3.9987387
9732	3.9882021	9792	3.9908714	9852	3.9935244	9912	3.9961613	9972	3.9987823
9733	3.9882467	9793	3.9909157	9853	3.9935685	9913	3.9962051	9973	3.9988258
9734	3.9882913	9794	3.9909601	9854	3.9936125	9914	3.9962489	9974	3.9988694
9735	3.9883359	9795	3.9910044	9855	3.9936566	9915	3.9962927	9975	3.9989129
9736	3.9883806	9796	3.9910488	9856	3.9937007	9916	3.9963365	9976	3.9989564
9737	3.9884252	9797	3.9910931	9857	3.9937447	9917	3.9963803	9977	3.9990000
9738	3.9884698	9798	3.9911374	9858	3.9937888	9918	3.9964241	9978	3.9990435
9739	3.9885144	9799	3.9911817	9859	3.9938329	9919	3.9964679	9979	3.9990870
9740	3.9885589	9800	3.9912261	9860	3.9938769	9920	3.9965117	9980	3.9991305
9741	3.9886035	9801	3.9912704	9861	3.9939209	9921	3.9965554	9981	3.9991740
9742	3.9886481	9802	3.9913147	9862	3.9939650	9922	3.9965992	9982	3.9992176
9743	3.9886927	9803	3.9913590	9863	3.9940090	9923	3.9966430	9983	3.9992611
9744	3.9887373	9804	3.9914033	9864	3.9940531	9924	3.9966867	9984	3.9993046
9745	3.9887818	9805	3.9914476	9865	3.9940971	9925	3.9967305	9985	3.9993481
9746	3.9888264	9806	3.9914919	9866	3.9941411	9926	3.9967743	9986	3.9993916
9747	3.9888710	9807	3.9915362	9867	3.9941851	9927	3.9968180	9987	3.9994350
9748	3.9889155	9808	3.9915804	9868	3.9942291	9928	3.9968618	9988	3.9994785
9749	3.9889600	9809	3.9916247	9869	3.9942731	9929	3.9969055	9989	3.9995220
9750	3.9890046	9810	3.9916690	9870	3.9943171	9930	3.9969492	9990	3.9995655
9751	3.9890491	9811	3.9917133	9871	3.9943611	9931	3.9969930	9991	3.9996089
9752	3.9890937	9812	3.9917575	9872	3.9944051	9932	3.9970367	9992	3.9996524
9753	3.9891382	9813	3.9918018	9873	3.9944491	9933	3.9970804	9993	3.9996959
9754	3.9891827	9814	3.9918460	9874	3.9944931	9934	3.9971241	9994	3.9997393
9755	3.9892273	9815	3.9918903	9875	3.9945371	9935	3.9971679	9995	3.9997828
9756	3.9892718	9816	3.9919345	9876	3.9945811	9936	3.9972116	9996	3.9998262
9757	3.9893163	9817	3.9919788	9877	3.9946250	9937	3.9972553	9997	3.9998697
9758	3.9893608	9818	3.9920230	9878	3.9946690	9938	3.9972990	9998	3.9999131
9759	3.9894053	9819	3.9920673	9879	3.9947130	9939	3.9973427	9999	3.9999566
9760	3.9894498	9820	3.9921115	9880	3.9947569	9940	3.9973864	10000	4.0000000

Of

Of Motion.	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time
Minutes.	0	H	1	H	2	H	3	H	4	H	5	H
Seconds.	0	0	60	0	120	0	180	I	240	I	300	II
0	0	0	822185	24	852288	48	869897	12	882391	36	892082	0
1	644370		822903		852648		870137		882571		892222	
2	674473		823609		853006		870377		882751		892370	
3	692082	1	824304	25	853360	49	870615	13	882931	37	892514	1
4	704576		824988		853712		870851		883109		892657	
5	714257	2	825661	26	854061	50	871087	14	883286	38	892800	2
6	722185		826324		854407		871321		883463		892942	
7	728879		826977		854750		871554		883639		893083	
8	734679	3	827620	27	855091	51	871785	15	883815	39	893225	3
9	739794		827255		855429		872086		883990		893365	
10	744370	4	828879	28	855764	52	872244	16	884164	40	893506	4
11	748509		829495		856297		872473		884337		893645	
12	752288		830103		856427		872700		884510		893785	
13	755764	5	830702	29	856755	53	872925	17	884682	41	893924	5
14	758982		831293		857080		873150		884853		894063	
15	761979	6	831876	30	857403	54	873373	18	885024	42	894201	6
16	764782		832451		857723		873595		885164		894338	
17	767414		833019		858042		873816		885363		894476	
18	769897	7	833579	31	858358	55	874036	19	885532	43	894616	7
19	772245		834132		858671		874254		885700		894746	
20	774473	8	834679	32	858982	56	874473	20	885467	44	894885	8
21	776592		835218		859092		874689		886034		895020	
22	778612		835751		859598		874905		886200		895155	
23	780542	9	836277	33	859903	57	875119	21	886365	45	895290	9
24	782391		836798		860206		875333		886530		895424	
25	784164	10	837311	34	860506	58	875445	22	886694	46	895558	10
26	785876		837819		860805		875756		886858		895691	
27	787586		838322		861101		875967		887021		895824	
28	789085	11	838819	35	861396	59	876176	23	887183	47	895957	11
29	790609		839309		861688		876384		887345		896089	
30	792082	12	839794	36	861979	I	876592	24	887506	48	896221	12
31	793506		840274		862267		876790		887667		896352	
32	794885		840748		862554		877003		887827		896483	
33	796221	13	841218	37	862836	1	877208	25	887986	49	896614	13
34	797517		841682		863122		877412		888145		896744	
35	798776	14	842142	38	863403	2	877613	26	888303	50	896874	14
36	800000		842597		863682		877815		888461		897004	
37	801190		843047		863960		878016		888618		897133	
38	802344	15	843492	39	864235	3	878215	27	888774	51	897261	15
39	803476		843933		864509		878414		888930		897390	
40	804576	16	844370	40	864782	4	878612	28	889085	52	897517	16
41	805648		844802		865052		878809		889240		897645	
42	806695		845230		865321		879004		889395		897772	
43	807716	17	845653	41	865588	5	879200	29	889548	53	897899	17
44	808715		846073		865854		879394		889701		898025	
45	809691	18	846488	42	866118	6	879588	30	889854	54	898152	18
46	810645		846900		866380		879780		890006		898277	
47	811579		847308		866641		879972		890158		898403	
48	812494	19	847712	43	866901	7	880162	31	890308	55	898528	19
49	813389		848112		867158		880353		890459		898652	
50	814267	20	848509	44	867415	8	880542	32	890609	56	898776	20
51	815127		848902		867669		880731		890758		898900	
52	815970		849291		867922		880928		890908		899024	
53	816797	21	849677	45	868174	9	881105	33	891156	57	899147	21
54	817609		850060		868425		881290		891204		899270	
55	818406	22	850439	46	868673	10	881476	34	891352	58	899362	22
56	819188		850815		868921		881661		891459		899515	
57	819957		851188		869167		881844		891644		899636	
58	820712	23	851558	47	869412	11	882027	35	891791	59	899758	23
59	821455		851924		869655		882209		891937		899876	
60	822185	24	852288	48	869897	12	882391	36	892082	II	900000	24

Seconds of Motion.

Minutes of Time.

Of Motion.	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time
Minutes.	6	H	7	H	8	H	9	H	10	H	11	H
Seconds.	360	II	420	II	480	III	540	III	600	IV	660	IV
0	900000	24	906695	48	912494	12	917609	36	922185	0	926324	24
1	900120		905798		912584		917689		922257		926390	
2	900240		906901		912674		917770		922329		926455	
3	900360	25	907004	49	912764	13	917850	37	922401	1	926521	25
4	900480		907106		912854		917929		922473		926586	
5	900599	26	907208	50	912944	14	918009	38	922545	2	926652	26
6	900718		907310		913033		918089		922617		926717	
7	900836		907412		913122		918168		922688		926782	
8	900954	27	907514	51	913212	15	918248	39	922760	3	926847	27
9	901072		907615		913300		918327		922831		926912	
10	901190	28	907716	52	913389	16	918406	40	922903	4	926977	28
11	901307		907817		913478		918485		922974		927042	
12	901424		907918		913566		918564		923045		927107	
13	901540	29	908018	53	913654	17	918642	41	923116	5	927171	29
14	901657		908119		913742		918721		923186		927236	
15	901773	30	908219	54	913830	18	918799	42	923257	6	927300	30
16	901887		908318		913918		918877		923328		927364	
17	902004		908418		914005		918955		923398		927428	
18	902119	31	908517	55	914093	19	919033	43	923468	7	927493	31
19	902234		908616		914180		919111		923539		927557	
20	902348	32	908715	56	914267	20	919188	44	923609	8	927620	32
21	902462		908813		914353		919266		923679		927684	
22	902576		908912		914440		919343		923749		927748	
23	902689	33	909011	57	914526	21	919420	45	923818	9	927812	33
24	902803		909108		914613		919498		923888		927875	
25	902916	34	909206	58	914699	22	919574	46	923958	10	927939	34
26	903028		909304		914785		919651		924027		928002	
27	903141		909401		914870		919728		924095		928065	
28	903253	35	909497	59	914956	23	919804	47	924166	11	928128	35
29	903365		909594		915041		919881		924235		928192	
30	903476	36	909691	III	915127	24	919957	48	924304	12	928255	36
31	903587		909787		915212		920033		924373		928317	
32	903698		909883		915297		920109		924441		928380	
33	903809	37	909979	1	915381	25	920185	49	924510	13	928443	37
34	903919		910075		915465		920261		924579		928506	
35	904029	38	910171	2	915550	26	920336	50	924647	14	928568	38
36	904139		910267		915635		920413		924715		928631	
37	904249		910361		915720		920487		924784		928693	
38	904358	39	910456	3	915803	27	920562	51	924852	15	928755	39
39	904467		910551		915886		920637		924920		928817	
40	904576	40	910645	4	915970	28	920712	52	924988	16	928879	40
41	904684		910740		916053		920787		925055		928941	
42	904792		910834		916137		920863		925123		929003	
43	904900	41	910928	5	916220	29	920936	53	925191	17	929065	41
44	905008		911021		916303		921011		925258		929127	
45	905115	42	911115	6	916383	30	921085	54	925326	18	929189	42
46	905222		911208		916468		921159		925393		929250	
47	905329		911301		916551		921233		925460		929312	
48	905436	43	911394	7	916633	31	921307	55	925527	19	929373	43
49	905542		911487		916715		921381		925594		929434	
50	905648	44	911579	8	916797	32	921455	56	925661	20	929495	44
51	905754		911672		916879		921527		925728		929557	
52	905859		911764		916961		921603		925794		929618	
53	905965	45	911856	9	917042	33	921675	57	925861	21	929679	45
54	906070		911947		917124		921748		921927		929739	
55	906174	46	912039	10	917205	34	921821	58	9259[illegible]4	22	929800	46
56	906279		912130		917286		921894		926060		929861	
57	906383		912221		917367		921967		926126		929922	
58	906487	47	912312	11	917448	35	922040	59	926292	23	929982	47
59	906591		912403		917528		922112		926258		930042	
60	906695	48	912494	12	917609	36	922185	IV	626324	24	930103	48

Seconds of Motion.

Minutes of Time.

Seconds of Motion.

Of Motion.	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time
Minutes.	12	H	13	H	14	H	15	H	16	H	17	H
Seconds.	720	IV	780	V	840	V	900	VI	960	VI	1020	VI
0	930103	48	933579	12	936798	36	939794	0	942597	24	945230	43
1	930163		933635		936849		939842		942542		945272	
2	930223		933690		936901		939898		942637		945315	
3	930283	49	933746	13	936952	37	939938	1	942732	25	945357	49
4	930343		933801		937004		939985		942777		945399	
5	930403	50	933857	14	937055	38	940034	2	942822	26	945442	50
6	930463		933912		937107		940082		942867		945484	
7	930523		933967		937158		940130		942912		945527	
8	930583	51	934022	15	937209	39	940178	3	942957	27	945569	51
9	930642		934077		937250		940226		943002		945611	
10	930700	52	934132	16	937311	40	940274	4	943047	28	945653	52
11	930761		934187		937362		940321		943091		945695	
12	930821		934242		937414		940369		943136		945737	
13	930880	53	934297	17	937465	41	940417	5	943181	29	945780	53
14	930939		934352		937515		940464		943225		945822	
15	930998	54	934406	18	937565	42	940512	6	943270	30	945864	54
16	931057		934461		937617		940559		943314		945906	
17	931116		934516		937668		940607		943359		945947	
18	931175	55	934570	19	937718	43	940364	7	943403	31	945939	55
19	931234		934624		937769		940701		943448		946031	
20	931292	56	934679	20	937819	44	940748	8	943492	32	946673	56
21	931351		934733		937869		940796		943536		946115	
22	931410		934787		937919		940843		943581		946156	
23	931468	57	934841	21	937971	45	940890	9	943625	33	946198	57
24	931527		934895		938021		940937		943669		946240	
25	931585	58	934949	22	938071	46	940984	10	943713	34	946281	58
26	931643		935003		938121		941031		943757		946323	
27	931702		935007		938172		941078		943801		946364	
28	931760	59	935111	23	938222	47	941124	11	943845	35	946406	59
29	931818		935164		938272		941171		943889		946447	
30	931876	V	935218	24	938322	48	941218	12	943933	36	946488	VII
31	931931		935272		938371		941265		943977		946530	
32	931991		935325		938421		941311		944021		946571	
33	932049	1	935378	25	938471	49	941358	13	944064	37	946612	1
34	632107		935432		938521		941404		944108		946654	
35	932164	2	935485	26	938570	50	941451	14	944152	38	946695	2
36	932222		935539		938620		941497		944195		946737	
37	932279		935592		938670		941544		944239		946777	
38	932337	3	935645	27	938720	51	941590	15	944283	39	946818	3
39	932394		935698		938768		941636		944326		946859	
40	932451	4	935751	28	938818	52	941682	16	944370	40	946899	4
41	932508		935804		938867		941729		944413		946941	
42	932565		935857		938916		941775		944456		946982	
43	932622	5	935910	29	938966	53	941821	17	944500	41	947023	5
44	932679		935962		939015		941867		944543		947064	
45	932736	6	936015	30	939064	54	941913	18	944586	42	947105	6
46	932792		936[illegible]63		939113		941959		944629		947145	
47	932849		936120		939162		942005		944673		947186	
48	932906	7	936173	31	939211	55	942010	19	944716	43	947227	7
49	932962		936225		939260		942096		944759		947267	
50	933019	8	936277	32	939309	56	942142	20	944802	44	947307	8
51	933075		936330		939357		942188		944845		947349	
52	933131		936382		939406		942233		944888		947389	
53	933188	9	936434	33	939455	57	942279	21	944930	45	947430	9
54	933244		936486		939503		942324		944973		947470	
55	933300	10	936538	34	939552	58	942370	22	945016	46	947511	10
56	933356		936590		939600		942415		945059		947551	
57	933412		936642		939649		942461		945102		947591	
58	933468	11	936694	35	939697	59	942506	23	945145	47	947631	11
59	933523		936746		939746		942550		945187		947672	
60	933579	12	936798	36	939794	VI	942597	24	945230	48	947712	12

Minutes of Time.

Of Motion.	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time
Minutes.	18	H	19	H	20	H	21	H	22	H	23	H
Seconds.	1080	VII	1140	VII	1300	VIII	1260	VIII	1320	VIII	1380	IX
0	947712	12	950060	36	952288	0	954407	24	956427	48	958358	12
1	947752		950098		952324		954441		956460		958389	
2	947791		950136		952360		954476		956490		958420	
3	947832	13	950174	37	952396	1	954510	25	956525	49	958452	13
4	947873		950212		952432		954544		956558		958483	
5	947913	14	950250	38	952468	2	954579	26	956591	50	958515	14
6	947953		950288		952504		954613		956624		958546	
7	947993		950326		952540		954647		956657		958577	
8	948033	15	950364	39	952576	3	954682	27	956689	51	958609	15
9	948072		950402		952612		954716		956722		958640	
10	948112	16	950440	40	952648	4	954750	28	956755	52	958671	16
11	948152		950478		952684		954784		956787		958702	
12	948192		950515		952720		954818		956820		958734	
13	948232	17	950553	41	952756	5	954852	29	956853	53	958765	17
14	948272		950590		952791		954887		956885		958796	
15	948311	18	950628	42	952827	6	954921	30	956918	54	958827	18
16	948351		950665		952863		954955		956950		958858	
17	948390		950703		952899		954989		956983		958889	
18	948430	19	950740	43	952934	7	955023	31	957015	55	958920	19
19	948469		950778		952970		955057		957048		958951	
20	948509	20	950815	44	953006	8	955091	32	957080	56	958982	20
21	948548		950853		953041		955125		957112		959013	
22	948588		950890		953077		955158		957145		959044	
23	948627	21	950928	45	953112	9	955162	33	957177	57	959075	21
24	948667		950965		953148		955226		957210		959106	
25	948706	22	951002	46	953183	10	955260	34	957242	58	959137	22
26	948745		951039		953219		955294		957274		959168	
27	948784		951076		953254		955327		957306		959199	
28	948824	23	951114	47	953289	11	955361	35	957339	59	959230	23
29	948863		951151		953325		955395		957371		959261	
30	948902	24	951188	48	953360	12	955429	36	957406	IX	959292	24
31	948941		951225		953395		955462		957435		959322	
32	948980		951262		953431		955496		957467		959353	
33	949019	25	951299	49	953466	13	955529	37	957499	1	959384	25
34	649058		951336		953501		955563		957531		959415	
35	949097	26	951373	50	953536	14	955597	38	957503	2	959446	26
36	949136		951410		953571		955636		957595		959476	
37	949175		951447		953607		955664		957628		959507	
38	949214	27	951484	51	953642	15	955697	39	957660	3	959537	27
39	949253		951521		953677		955731		957692		959568	
40	949291	28	951558	52	952712	16	955764	40	957723	4	959598	28
41	949330		951594		953747		955797		957755		959629	
42	949369		951631		953782		955831		957787		959660	
43	949408	29	951668	53	953817	17	955864	41	957819	5	959690	29
44	949446		951705		953852		955897		957851		959721	
45	949485	30	951741	54	953887	18	955931	42	957883	6	959751	30
46	949523		951778		953921		955964		957915		959782	
47	949562		951815		953956		955997		957946		959812	
48	949601	31	951851	55	953991	19	956030	43	957978	7	959842	31
49	949639		951888		954026		956064		958010		959872	
50	949677	32	951924	56	954061	20	956097	44	958042	8	959903	32
51	949716		951961		954095		956130		958073		959934	
52	949754		951997		954130		956163		958105		959964	
53	949793	33	952034	57	954165	21	956196	45	958137	9	959994	33
54	649831		952070		954199		956229		958168		960025	
55	949869	34	952106	58	954234	22	956262	46	958200	10	960055	34
56	949907		952143		954269		956295		958231		960085	
57	949946		952179		954303		956328		958263		960115	
58	949984	35	952215	59	954338	23	956361	47	958295	11	960145	35
59	950022		952252		954372		956394		958326		960176	
60	950060	36	952288	VIII	954407	24	956427	48	958358	12	960206	36

Seconds of Motion.

Minutes of Time.

Of Motion	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time
Minutes.	24	H	25	H	26	H	27	H	28	H	29	H
Seconds.	1440	IX	1500	X	1560	X	1620	X	1680	XI	1740	XI
0	960206	36	961979	0	963682	24	965321	48	966901	12	968425	36
1	960236		962008		963710		965348		966926		968449	
2	960266		962037		963738		965375		966952		958473	
3	960295	37	962065	1	963765	25	965401	49	966978	13	958499	37
4	960326		962094		963793		965428		967004		968524	
5	960356	38	962123	2	963821	26	965455	50	967030	14	968549	38
6	960386		962152		963849		965482		967055		968574	
7	960416		962181		963875		965508		967081		968599	
8	960446	39	962210	3	963904	27	965535	51	967107	15	968624	39
9	960476		962239		963932		965562		967133		568649	
10	960506	40	962267	4	963960	28	965588	52	967158	16	568673	40
11	960536		962296		963987		965615		967184		968698	
12	960566		962325		964015		965642		967210		968723	
13	960596	41	962353	5	964042	29	965668	53	967235	17	968748	41
14	960626		962382		964070		965695		967261		968773	
15	960656	42	962411	6	964098	30	965721	54	967287	18	968797	42
16	960686		962440		964125		965748		967312		968822	
17	960716		962468		964153		965774		967338		958847	
18	960745	43	962497	7	964180	31	965801	55	967363	19	968871	43
19	960775		962525		964208		965827		967389		968896	
20	960805	44	962554	8	964235	32	965854	56	967414	20	968921	44
21	960835		962583		964263		965880		967439		968946	
22	960864		962611		964290		965907		967466		968970	
23	960894	45	962640	9	964318	33	965933	57	967491	21	968995	45
24	960924		962668		964345		965960		967517		969019	
25	960953	46	962697	10	964373	34	965980	58	967542	22	969044	46
26	960983		962725		964400		966063		967568		969069	
27	961013		962754		964427		966039		967595		969063	
28	961042	47	962782	11	964455	35	966065	59	967618	23	959118	47
29	961072		962810		964482		966092		967644		969142	
30	961101	48	962839	12	964509	36	966118	XI	967688	24	959167	48
31	961131		962867		964537		966144		967695		969191	
32	961160		962895		964564		966171		967720		969216	
33	961190	49	962925	13	964591	37	966197	1	967745	25	959240	49
34	961219		962952		964618		966223		967771		969265	
35	961249	50	962980	14	964646	38	966249	2	967796	26	959289	50
36	961278		963009		964674		966276		967821		969314	
37	961308		963037		964700		966302		967847		969338	
38	961337	51	963065	15	964727	39	966328	3	967872	27	969363	51
39	961366		963093		964754		966354		967897		969390	
40	961396	52	963122	16	964782	40	966380	4	967922	28	569412	52
41	961425		963150		964809		966407		967948		969436	
42	961454		963178		964836		966433		967973		969460	
43	961484	53	963206	17	964863	41	966459	5	967998	29	969485	53
44	961513		963234		964890		966485		968023		969509	
45	961542	54	963262	18	964917	42	966511	6	968049	30	969533	54
46	961571		963291		964944		966537		968074		969558	
47	961601		963320		964971		966563		968099		969582	
48	961630	55	963347	19	964998	43	966589	7	968124	31	969606	55
49	961659		963375		965025		966615		968149		969631	
50	961688	56	963403	20	965052	44	966641	8	968174	32	969655	56
51	961717		963431		965079		966667		968199		569680	
52	961746		963431		965106		966693		968224		969703	
53	961775	57	963487	21	965133	45	966719	9	968249	33	969728	57
54	961805		963515		965160		966745		968275		969752	
55	961834	58	963543	22	965187	46	966771	10	968300	34	969776	58
56	961863		963571		965214		966797		568325		969800	
57	961892		963598		965241		966823		968350		969824	
58	961921	59	963626	23	965267	47	966849	11	968375	35	969848	59
59	961950		963654		965294		966875		968400		969873	
60	961979	X	963682	24	965321	48	966901	12	568425	36	969897	XII

Seconds of Motion.

Minutes of Time.

Seconds of Motion. / Minutes of Time.

Of Motion	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time
Minutes.	30	H	31	H	32	H	33	H	34	H	35	H
Seconds.	1800	XII	1860	XII	1920	XIII	1980	XIII	2040	XIII	2100	XIV
0	969897	0	971321	24	972700	48	974036	12	975333	36	976592	0
1	969921		971344		972723		974088		975355		976612	
2	969944		971368		972745		974080		975375		976633	
3	969969	1	971391	25	972768	49	974102	13	975397	37	976654	1
4	969993		971414		972790		974124		975418		976675	
5	970017	2	971437	26	972813	50	974145	14	975439	38	976695	2
6	970041		971461		972836		974168		975460		976715	
7	970065		971484		972858		974191		975481		976736	
8	970089	3	971507	27	972880	51	974211	15	975503	39	976757	3
9	970113		971531		972903		974233		975524		976778	
10	970137	4	971554	28	972925	52	974255	16	975545	40	976798	4
11	970161		971577		972948		974277		975566		976818	
12	970185		971600		972970		974299		975588		976839	
13	970209	5	971623	29	972993	53	974320	17	975608	41	976860	5
14	970233		971647		973015		974342		975630		976880	
15	970257	6	971670	30	973038	54	974364	18	975651	42	976901	6
16	970281		971693		973160		974380		975672		976922	
17	970305		971716		973183		974407		975693		976942	
18	970330	7	971740	31	973205	55	974429	19	975714	43	976962	7
19	970353		971762		973227		974451		975735		976982	
20	970377	8	971785	32	973250	56	974473	20	975756	44	976003	8
21	970399		971808		973273		974494		975777		977024	
22	970424		971832		973295		974516		975799		977044	
23	970448	9	971855	33	973217	57	974538	21	975820	45	977065	9
24	970472		971878		973239		974560		975841		977085	
25	970496	10	971901	34	973262	58	974581	22	975862	46	977106	10
26	970520		971924		973284		974603		975884		977126	
27	970543		971947		973306		974624		975904		977146	
28	970567	11	971970	35	973329	59	974646	23	975925	47	977167	11
29	970591		971993		973351		974668		975946		977187	
30	970615	12	972016	36	973374	XIII	974690	24	975967	48	977208	12
31	970638		972039		973395		974711		976988		977228	
32	970662		972062		973418		974732		976009		977248	
33	970686	13	972085	37	973440	1	974754	25	976030	49	977269	13
34	970709		972108		973462		974776		976050		977289	
35	970733	14	972131	38	973484	2	974798	26	976071	50	977309	14
36	970757		972153		973506		974819		976092		977330	
37	970781		972176		973528		974840		976113		977350	
38	970804	15	972199	39	973550	3	974862	27	976134	51	977370	15
39	970828		972222		973572		974883		976155		977391	
40	970851	16	972245	40	973595	4	974905	28	976176	52	977411	16
41	970875		972268		973617		974927		976197		977431	
42	970899		972291		973640		974948		976218		977452	
43	970922	17	972313	41	973662	5	974969	29	976239	53	977472	17
44	970946		972336		973684		974990		976259		977492	
45	970970	18	972359	42	973706	6	975012	30	976280	54	977513	18
46	970994		972382		973728		975034		976301		977533	
47	971017		972405		973750		975056		976322		977553	
48	971040	19	972437	43	973772	7	975077	31	976343	55	977573	19
49	971063		972450		973794		975098		976364		977593	
50	971087	20	972473	44	973816	8	975119	32	976384	56	977613	20
51	971110		972496		973838		975141		976404		977634	
52	971133		972518		973860		975163		976426		977654	
53	971157	21	972540	45	973883	9	975183	33	976447	57	977674	21
54	971181		972563		973904		975205		976469		977694	
55	971204	22	972586	46	973926	10	975227	34	976488	58	977714	22
56	971227		972609		973948		975249		976509		977734	
57	971251		972623		973970		975268		976529		977755	
58	971274	23	972654	47	973992	11	975290	35	976550	59	977775	23
59	971298		972677		974014		975311		976571		977795	
60	931321	24	972700	48	974036	12	975333	36	976591	XIV	677815	24

Of Motion.	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time
Minutes.	36	H	37	H	38	H	39	H	40	H	41	H
Seconds.	2160	XIV	2220	XIV	2280	XV	2340	XV	2400	XVI	2460.	XVI
0	977815	24	979005	48	980163	12	981291	36	982391	0	983463	24
1	977835		979024		980182		981310		982409		983481	
2	977855		979044		980201		981328		982427		983498	
3	977875	25	979063	49	980220	13	981347	37	982445	1	983516	25
4	977895		979083		980239		981365		982463		983534	
5	977915	26	979103	50	980250	14	981384	38	982481	2	983551	26
6	977935		979122		980277		981402		982499		983569	
7	977955		979142		980296		981421		982517		983587	
8	977975	27	979161	51	980305	15	981440	39	982535	3	983604	27
9	977995		979181		980334		981458		982553		983622	
10	978015	28	979200	52	980353	16	981476	40	982571	4	983639	28
11	978035		979220		980372		981495		982589		983657	
12	978055		979240		980391		981513		982607		983674	
13	978075	29	979258	53	980410	17	981532	41	982625	5	983692	29
14	978095		979279		980429		981550		982643		983710	
15	978115	30	979297	54	980448	18	981569	42	982661	6	983727	30
16	978135		979316		980467		981587		982699		983745	
17	978155		979336		980486		981605		982697		983762	
18	978175	31	979355	55	980505	19	981624	43	982715	7	983780	31
19	978195		979375		980524		981642		982733		983798	
20	978215	32	979394	56	980543	20	981661	44	982751	8	983815	32
21	978235		979414		980561		981680		982769		983832	
22	978255		979434		980580		981698		982787		983850	
23	978275	33	979453	57	980599	21	981716	45	982805	9	983867	33
24	978295		979472		980619		981734		982823		983885	
25	978315	34	979491	58	980637	22	981753	46	982841	10	983902	34
26	978335		979510		980656		981771		982859		983920	
27	978354		979530		980674		981789		982877		983937	
28	978374	35	979549	59	980693	23	981808	47	982893	11	983955	35
29	978394		979569		980712		981826		982912		983972	
30	978414	36	979588	XV	980731	24	981844	48	982930	12	983990	35
31	978434		979607		980750		981863		982948		984007	
32	978454		979626		980768		981881		982966		984024	
33	978473	37	979645	1	980787	25	981890	49	982984	13	984043	37
34	978493		979665		980806		981918		983002		984059	
35	978513	38	979684	2	980825	26	981936	50	983020	14	984077	38
36	978533		979704		980843		981954		983037		984094	
37	978553		979723		980862		981973		983055		984111	
38	978573	39	979742	3	980881	27	981991	51	983073	15	984129	39
39	978592		979761		980900		982009		983091		984146	
40	978612	40	979780	4	980918	28	982027	52	983109	16	984164	40
41	978632		979800		980937		982046		983126		984181	
42	978652		979819		980956		982064		983144		984198	
43	978671	41	979838	5	980975	29	982082	53	983162	17	984216	41
44	978691		979857		980993		982100		983179		984233	
45	978710	42	979876	6	981612	30	982118	54	983197	18	984250	42
46	978730		979895		981031		982137		983215		984268	
47	978750		979915		981050		982155		983233		984285	
48	978770	43	979934	7	981068	31	982173	55	983251	19	984302	43
49	978789		979953		981087		982191		983268		984320	
50	978809	44	979972	8	981105	32	982209	56	983286	20	984337	44
51	978828		979991		981124		982228		983304		984354	
52	978843		980010		981142		982246		983322		984375	
53	978868	45	980029	9	981161	33	982264	57	983339	21	984389	45
54	978887		980049		981180		982282		983357		984406	
55	978907	46	980068	10	981198	34	982300	58	983375	22	984423	46
56	978927		980087		981217		982318		983393		984441	
57	978946		980106		981235		982336		983410		984458	
58	978966	47	980125	11	981254	35	982355	59	983428	23	984475	47
59	978985		980144		981273		982373		983445		984492	
60	979005	48	980163	12	981291	35	982391	XVI	983463	24	984510	48

Seconds of Motion. Minutes of Time.

Of Motion.	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time
Minutes.	42	H	43	H	44	H	45	H	46	H	47	H
Seconds.	2520	XVI	2580	XVII	2640	XVII	2700	XVIII	2760	XVIII	2820	XVIII
0	984510	48	985532	12	986530	36	987506	0	988461	24	989395	48
1	984527		985548		986546		987522		988476		989410	
2	984544		985565		986563		987538		988492		989425	
3	984561	49	985582	13	986579	37	987554	1	988508	25	989440	49
4	984579		985599		986596		987570		988523		989456	
5	984586	50	985616	14	986612	38	987586	2	988539	26	989471	50
6	984613		985632		986629		987602		988555		989487	
7	984630		985649		986645		987618		988571		989502	
8	984647	51	985666	15	986661	39	987634	3	988586	27	989518	51
9	984664		985683		986678		987651		988602		989533	
10	984682	52	985700	16	986694	40	987667	4	988618	28	989548	52
11	984699		985716		986711		987683		988633		989564	
12	984716		985733		986727		987699		988649		989579	
13	984733	53	985750	17	986743	41	987715	5	988665	29	989594	53
14	984750		985767		986760		987731		988680		989610	
15	984767	54	985783	18	986776	42	987747	6	988696	30	989625	54
16	984785		985800		986792		987763		988712		989640	
17	984802		985817		986809		987778		988727		989656	
18	984819	55	985834	19	986825	43	987795	7	988743	31	989671	55
19	984836		985850		986841		987811		988758		989686	
20	984853	56	985867	20	986858	44	987826	8	988774	32	989701	56
21	984870		985884		986874		987842		988790		989717	
22	984887		985900		986890		987858		988805		989732	
23	984903	57	985917	21	986907	45	987874	9	988821	33	989747	57
24	984921		985934		986923		987890		988837		989763	
25	984938	58	985950	22	986939	46	987906	10	988852	34	989778	58
26	984955		985967		986956		987922		988868		989793	
27	984972		985984		986972		987938		988883		989808	
28	984990	59	986000	23	986988	47	987954	11	988899	35	989824	59
29	985007		986017		987004		987970		988914		989839	
30	985024	XVII	986034	24	987021	48	987986	12	988929	36	989854	XIX
31	985041		986050		987037		988002		988946		989869	
32	985058		926067		987053		988018		988961		989885	
33	985075	1	986084	25	987069	49	988034	13	988977	37	989900	1
34	985092		986100		987086		988049		988992		989915	
35	985109	2	986117	26	987102	50	988065	14	989008	38	989930	2
36	985126		986133		987118		988081		989023		989945	
37	985143		986150		987134		988097		989039		989961	
38	985160	3	986167	27	987151	51	988113	15	989054	39	989976	3
39	985177		986183		987167		988129		989070		989991	
40	985194	4	986200	28	987183	52	988145	16	989085	40	990006	4
41	985211		986216		987199		988161		989101		990021	
42	985228		986233		987215		988176		989116		990037	
43	985244	5	986249	29	987232	53	988192	17	989132	41	990052	5
44	985261		986266		987248		988208		989147		990067	
45	985278	6	986283	30	987264	54	988224	18	989163	42	990082	6
46	985295		986299		987280		988240		989178		990097	
47	985312		986316		987296		988255		989194		990112	
48	985327	7	986332	31	987313	55	988271	19	989209	43	990128	7
49	985346		986349		987329		988287		989225		990143	
50	985363	8	986365	32	987345	56	988303	20	989240	44	990158	8
51	985380		986382		987361		988319		989256		990173	
52	985397		986398		987377		988334		989271		990188	
53	985414	9	986415	33	987393	57	988350	21	989286	45	990203	9
54	985430		986431		987409		988366		989302		990218	
55	985447	10	986448	34	987425	58	988382	22	989317	46	990233	10
56	985464		986464		987442		988398		989333		990248	
57	985481		986481		987458		988413		989348		990264	
58	985498	11	986498	35	987474	59	988429	23	989364	47	990279	11
59	985515		986514		987490		988445		989379		990294	
60	985532	12	986530	36	987506	XVIII	988461	24	989395	48	990309	12

Seconds of Motion.

Minutes of Time.

Logiſtical Logarithms.

Of Motion.	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time
Minutes.	48	H	49	H	50	H	51	H	52	H	53	H
Seconds.	2880	XIX	2940	XIX	3000	XX	3060	XX	3120	XX	3180	XXI
0	990309	12	991204	36	992082	0	992942	24	993785	48	994612	12
1	990324		991219		992096		992956		993799		994626	
2	990339		991234		992111		992970		993813		994640	
3	990354	13	991249	37	992125	1	992984	25	993827	49	994654	13
4	990369		991263		992140		992998		993841		994657	
5	990384	14	991278	38	992154	2	993013	26	993855	50	994681	14
6	990399		991293		992168		993027		993868		994695	
7	990414		991308		992183		993041		993882		994708	
8	990429	15	991322	39	992197	3	993055	27	993896	51	994721	15
9	990444		991337		992212		993069		993910		994735	
10	990459	16	991352	40	992226	4	993083	28	993924	52	994749	16
11	990474		991367		992240		993098		993938		994762	
12	990489		991381		992255		993112		993952		994776	
13	990504	17	991395	41	992270	5	993126	29	993966	53	994789	17
14	990529		991411		992284		993140		993979		994803	
15	990534	18	991425	42	992298	6	993154	30	993993	54	994817	18
16	990549		991440		992313		993168		994007		994830	
17	990564		991455		992327		993182		994021		994844	
18	990579	19	991469	43	992342	7	993196	31	994035	55	994857	19
19	990594		991484		992356		993211		994049		994871	
20	990609	20	991499	44	992370	8	993225	32	994063	56	994885	20
21	990624		991513		992385		993239		994076		994899	
22	990639		991528		992399		993253		994090		994912	
23	990654	21	991543	45	992413	9	993267	33	994104	57	994925	21
24	990669		991558		992427		993281		994118		994938	
25	990684	22	991572	46	992442	10	993295	34	994132	58	994952	22
26	990699		991587		992456		993309		994146		994966	
27	990714		991601		992470		993323		994160		994979	
28	990729	23	991616	47	992484	11	993337	35	994174	59	994993	23
29	990744		991631		992498		993351		994187		995007	
30	990759	24	991645	48	992512	12	993365	36	994201	XXI	995020	24
31	990774		991660		992527		993380		994215		995034	
32	990789		991674		992543		993394		994228		995047	
33	990804	25	991689	49	992557	13	993408	37	994242	1	995061	25
34	990819		991704		992571		993422		994256		995074	
35	990833	26	991718	50	992585	14	993436	38	994270	2	995088	26
36	990848		991733		992600		993450		994284		995101	
37	990864		991747		992614		993464		994297		995115	
38	990878	27	991762	51	992628	15	993478	39	994311	3	995128	27
39	990883		991777		992643		993492		994325		995142	
40	990908	28	991791	52	992657	16	993506	40	994338	4	995155	28
41	990923		991806		992671		993520		994352		995169	
42	990939		991820		992686		993534		994366		995182	
43	990952	29	991835	53	992700	17	993548	41	994380	5	995196	29
44	990967		991849		992714		993562		994393		995209	
45	990982	30	991864	54	992728	18	993576	42	994407	6	995223	30
46	990997		991879		992743		993590		994421		995236	
47	991012		991893		992757		993604		994435		995250	
48	991027	31	991908	55	992771	19	993618	43	994448	7	995263	31
49	991042		991922		992785		993632		994462		995276	
50	991056	32	991937	56	992800	20	993646	44	994476	8	995290	32
51	991071		991951		992814		993660		994489		995303	
52	991086		991966		992828		993674		994503		995317	
53	991101	33	991980	57	992843	21	993688	45	994517	9	995330	33
54	991116		991995		992857		993701		994530		995344	
55	991130	34	992009	58	992871	22	993715	46	994544	10	995357	34
56	991145		992024		992885		993729		994558		995370	
57	991160		992038		992899		993743		994571		995384	
58	991175	35	992053	59	992913	23	993757	47	994585	11	995397	35
59	991190		992068		992928		993771		994599		995411	
60	991204	36	992082	XX	992942	24	993785	48	994612	12	995424	36

Seconds of Motion.

Minutes of Time.

Of Motion.	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time	Motion.	Time
Minutes.	54	H	55	H	56	H	57	H	58	H	59	H
Seconds.	3240	XXI	3300	XXII	3360	XXII	3420	XXII	3480	XXIII	3540	XXIII
0	995424	36	996221	0	997004	24	997772	48	998528	12	999270	36
1	995437		996234		997017		997785		998540		999282	
2	995451		996247		997020		997798		998553		999294	
3	995465	37	996260	1	997042	25	997810	49	998565	13	999306	37
4	995478		996274		997055		997823		998577		999319	
5	995491	38	996287	2	997068	26	997836	50	998590	14	999331	38
6	995504		996300		997081		997848		998602		999343	
7	995518		996313		997094		997861		998615		999356	
8	995531	39	996326	3	997107	27	997874	51	998627	15	999368	39
9	995545		996339		997120		997886		998640		999380	
10	995558	40	996352	4	997132	28	997899	52	998653	16	999392	40
11	995571		996365		997145		997912		998665		999405	
12	995585		996380		997158		997925		998677		999417	
13	995598	41	996392	5	997171	29	997937	53	998689	17	999429	41
14	995611		996405		997184		997950		998702		999441	
15	995625	42	996418	6	997197	30	997963	54	998714	18	999453	42
16	995638		996431		997210		997975		998727		999466	
17	995651		996444		997223		997988		998739		999478	
18	995665	43	996457	7	997236	31	998000	55	998752	19	999490	43
19	995678		996470		997249		998013		998764		999502	
20	995691	44	996483	8	997261	32	998025	56	998776	20	999515	44
21	995705		996496		997274		998038		998789		999527	
22	995718		996510		997287		998051		998801		999539	
23	995731	45	996523	9	997300	33	998063	57	998813	21	999551	45
24	995745		996536		997313		998076		998826		999563	
25	995758	46	996549	10	997325	34	998089	58	998838	22	999575	46
26	995771		996562		997338		998101		998851		999588	
27	995785		996575		997351		998114		998863		999600	
28	995798	47	996588	11	997364	35	998126	59	998876	23	999612	47
29	995811		996601		997377		998139		998888		999624	
30	995814	48	996614	12	997390	36	998152	XXIII	998900	24	999636	48
31	995837		996627		997402		998165		998913		999649	
32	995851		996640		997415		998177		998925		999661	
33	995864	49	996653	13	997428	37	998189	1	998937	25	999673	49
34	995877		996666		997441		998202		998949		999685	
35	995891	50	996679	14	997454	38	998214	2	998962	26	999697	50
36	995903		996692		997466		998227		998974		999709	
37	995917		996705		997479		998240		998987		999721	
38	995930	51	996718	15	997492	39	998252	3	998999	27	999734	51
39	995944		996731		997505		998265		999012		999746	
40	995958	52	996744	16	997517	40	998278	4	999024	28	999758	52
41	995970		996757		997530		998290		999036		999770	
42	995983		996770		997543		998302		999049		999782	
43	995997	53	996783	17	997556	41	998315	5	999061	29	999794	53
44	996010		996796		997569		998327		999073		999806	
45	996023	54	996809	18	997581	42	998340	6	999086	30	999818	54
46	996036		996812		997594		998352		999098		999831	
47	996050		996835		997607		998365		999110		999843	
48	996063	55	996848	19	997620	43	998378	7	999122	31	999855	55
49	996076		996861		997632		998390		999135		999867	
50	996089	56	996874	20	997645	44	998403	8	999147	32	999879	56
51	996102		996887		997658		998415		999159		999891	
52	996116		996900		997671		998428		999172		999903	
53	996129	57	996913	21	997683	45	998440	9	999184	33	999915	57
54	996142		996926		997696		998453		999196		999927	
55	996155	58	996939	22	997709	46	998465	10	999209	34	999939	58
56	996168		996952		997721		998478		999221		999951	
57	996181		996965		997734		998490		999232		999963	
58	996195	59	996978	23	997747	47	998503	11	999245	35	999976	59
59	996208		996991		997760		998515		999258		999988	
60	996221	XXII	997004	24	997772	48	998528	12	999270	36	100000	XXIV

Seconds of Motion.

Minutes of Time.

S	Log.1°0′	Log.1°1′	Log.1°2′	Log.1°3′	Log.1°4′	Log.1°5′
0	1000000	1000718	1001424	1002119	1002803	1003476
1	1000012	1000730	1001435	1002130	1002814	1003487
2	1000024	1000742	1001447	1002142	1002825	1003498
3	1000035	1000754	1001459	1002153	1002836	1003509
4	1000048	1000765	1001471	1002165	1002848	1003520
5	1000060	1000777	1001483	1002176	1002859	1003531
6	1000072	1000789	1001495	1002188	1002871	1003542
7	1000084	1000801	1001505	1002199	1002882	1003554
8	1000096	1000813	1001517	1002211	1002893	1003565
9	1000013	1000825	1001529	1002223	1002904	1003576
10	1000120	1000837	1001540	1002234	1002916	1003587
11	1000132	1000848	1001552	1002245	1002927	1003598
12	1000144	1000860	1001564	1002256	1002938	1003609
13	1000156	1000872	1001575	1002268	1002949	1003620
14	1000168	1000884	1001587	1002279	1002961	1003631
15	1000180	1000895	1001599	1002291	1002972	1003642
16	1000192	1000907	1001610	1002302	1002983	1003653
17	1000204	1000919	1001622	1002313	1002995	1003664
18	1000216	1000931	1001634	1002325	1003006	1003675
19	1000228	1000943	1001646	1002337	1003017	1003686
20	1000240	1000954	1001658	1002348	1003028	1003698
21	1000252	1000966	1001668	1002360	1003040	1003709
22	1000264	1000978	1001680	1002371	1003051	1003720
23	1000276	1000990	1001692	1002382	1003062	1003731
24	1000288	1001001	1001703	1002394	1003073	1003742
25	1000300	1001013	1001715	1002405	1003084	1003753
26	1000312	1001025	1001726	1002417	1003096	1003764
27	1000324	1001037	1001738	1002428	1003108	1003775
28	1000336	1001049	1001750	1002439	1003119	1003786
29	1000348	1001060	1001761	1002450	1003130	1003797
30	1000360	1001072	1001773	1002462	1003141	1003808
31	1000372	1001084	1001784	1002473	1003152	1003819
32	1000384	1001096	1001796	1002485	1003163	1003830
33	1000396	1001108	1001807	1002496	1003174	1003841
34	1000408	1001120	1001819	1002508	1003185	1003852
35	1000420	1001131	1001831	1002519	1003197	1003863
36	1000432	1001143	1001843	1002530	1003208	1003874
37	1000444	1001155	1001855	1002542	1003219	1003885
38	1000456	1001166	1001865	1002553	1003230	1003896
39	1000468	1001178	1001877	1002565	1003242	1003907
40	1000480	1001190	1001888	1002576	1003253	1003918
41	1000492	1001202	1001900	1002587	1003264	1003929
42	1000504	1001214	1001912	1002599	1003275	1003940
43	1000516	1001226	1001923	1002610	1003286	1003951
44	1000528	1001237	1001934	1002621	1003298	1003962
45	1000540	1001248	1001945	1002632	1003309	1003973
46	1000552	1001260	1001956	1002644	1003320	1003984
47	1000563	1001272	1001969	1002656	1003331	1003995
48	1000375	1001284	1001981	1002667	1003342	1004006
49	1000587	1001296	1001993	1002678	1003353	1004018
50	1000599	1001307	1002004	1002689	1003365	1004029
51	1000611	1001319	1002016	1002701	1003376	1004040
52	1000623	1001330	1002028	1002712	1003387	1004051
53	1000635	1001342	1002038	1002723	1003398	1004062
54	1000647	1001354	1002050	1002735	1003409	1004073
55	1000659	1001366	1002061	1002746	1003420	1004084
56	1000670	1001377	1002073	1002757	1003431	1004095
57	1000682	1001389	1002084	1002769	1003442	1004106
58	1000694	1001390	1002096	1002780	1003454	1004117
59	1000706	1001412	1002107	1002792	1003465	1004128
60	1000718	1001424	1002119	1002803	1003476	1004139

S	Log.1°6′	Log.1°7′	Log.1°8′	Log.1°9′	Lo.1°10′	Lo.1°11′
0	1004139	1004793	1005436	1006070	1006695	1007311
1	1004150	1004803	1005447	1006080	1006705	1007321
2	1004161	1004814	1005457	1006091	1006715	1007331
3	1004172	1004825	1005468	1006101	1006726	1007341
4	1004183	1004836	1005478	1006112	1006736	1007351
5	1004194	1004847	1005489	1006122	1006746	1007362
6	1004205	1004858	1005499	1006133	1006756	1007372
7	1004216	1004869	1005510	1006143	1006767	1007382
8	1004217	1004880	1005521	1006153	1006777	1007392
9	1004238	1004890	1005531	1006164	1006787	1007402
10	1004249	1004900	1005542	1006174	1006798	1007412
11	1004260	1004911	1005553	1006185	1006808	1007422
12	1004270	1004922	1005563	1006195	1006818	1007433
13	1004281	1004933	1005574	1006206	1006829	1007443
14	1004292	1004943	1005584	1006216	1006839	1007453
15	1004303	1004954	1005695	1006227	1006849	1007463
16	1004314	1004965	1005606	1006237	1006860	1007473
17	1004325	1004976	1005616	1006248	1006870	1007484
18	1004336	1004986	1005627	1006258	1006880	1007494
19	1004347	1004997	1005638	1006268	1006891	1007504
20	1004358	1005008	1005648	1006279	1006901	1007514
21	1004369	1005019	1005659	1006289	1006911	1007524
22	1004380	1005030	1005669	1006300	1006921	1007534
23	1004392	1005040	1005680	1006310	1006932	1007544
24	1004402	1005051	1005690	1006321	1006942	1007554
25	1004412	1005062	1005701	1006331	1006952	1007565
26	1004423	1005073	1005711	1006342	1006963	1007575
27	1004434	1005084	1005722	1006352	1006973	1007585
28	1004415	1005095	1005733	1006362	1006983	1007595
29	1004456	1005109	1005743	1006373	1006993	1007605
30	1004467	1005116	1005754	1006383	1007004	1007615
31	1004478	1005126	1005764	1006394	1007014	1007625
32	1004489	1005137	1005775	1006404	1007024	1007635
33	1004500	1005147	1005785	1006414	1007034	1007646
34	1004510	1005158	1005796	1006425	1007045	1007656
35	1004521	1005169	1005807	1006435	1007075	1007666
36	1004532	1005179	1005818	1006445	1007065	1007676
37	1004543	1005190	1005828	1006456	1007075	1007686
38	1004554	1005201	1005838	1006466	1007086	1007696
39	1004565	1005212	1005849	1006477	1007096	1007706
40	1004576	1005223	1005859	1006487	1007106	1007716
41	1004586	1005233	1005870	1006498	1007116	1007727
42	1004597	1005244	1005880	1006508	1007127	1007737
43	1004608	1005254	1005891	1006518	1007137	1007747
44	1004619	1005265	1005901	1006529	1007147	1007757
45	1004630	1005276	1005912	1006539	1007157	1007767
46	1004641	1005287	1005923	1006550	1007168	1007777
47	1004652	1005298	1005933	1006560	1007178	1007787
48	1004662	1005308	1005944	1006570	1007188	1007797
49	1004673	1005318	1005954	1006581	1007198	1007807
50	1004684	1005329	1005965	1006591	1007208	1007817
51	1004695	1005340	1005975	1006601	1007219	1007827
52	1004706	1005350	1005986	1006611	1007229	1007837
53	1004717	1005361	1005996	1006622	1007239	1007848
54	1004728	1005372	1006007	1006632	1007249	1007858
55	1004739	1005383	1006017	1006643	1007260	1007868
56	1004750	1005393	1006028	1006653	1007270	1007878
57	1004760	1005404	1006038	1006663	1007280	1007888
58	1004771	1005415	1006049	1006674	1007290	1007898
59	1004781	1005425	1006059	1006684	1007300	1007908
60	1004792	1005436	1006070	1006695	1007311	1007918

THE
CANON
OF
Artificial Sines and Tangents,

With their

Complements Arithmetical.

D.	Sign.	Co. Arith.					Tangent.		
0	0	10.000000	0.0000000	0.0000000	60	0	0	00.0000000	60
1	6.4637261	9.9999999	3.5362739	0.0000000	59	1	5.4637261	13.5362739	59
2	6.7647561	9.9999999	3.2352439	0.0000001	58	2	6.7647562	13.2352438	58
3	6.9408473	9.9999998	3.0591527	0.0000002	57	3	6.9408475	13.0591525	57
4	7.0657860	9.9999997	2.9342140	0.0000003	56	4	7.0657863	12.9342137	56
5	7.1626960	9.9999995	2.8373040	0.0000005	55	5	7.1626964	12.8373036	55
6	7.2418771	9.9999993	2.7581229	0.0000007	54	6	7.2418778	12.7581222	54
7	7.3088239	9.9999991	2,6911761	0.0000009	53	7	7.3088248	12.6911752	53
8	7.3668157	9.9999988	2.6331843	0.0000012	52	8	7.3668169	12.6331831	52
9	7.4179681	9.9999985	2.5820319	0.0000015	51	9	7.4179696	12.5820304	51
10	7.4637255	9.9999982	2.5362745	0.0000018	50	10	7.4637273	12.5362727	50
11	7.5051181	9.9999978	2.4948819	0.0000022	49	11	7.5051203	12.4948797	49
12	7.5429065	9.9999974	2.4570935	0.0000026	48	12	7.5429091	12.4570909	48
13	7.5776684	9.9999969	2.4223316	0.0000031	47	13	7.5776715	12.4223285	47
14	7.6098530	9.9999964	2.3901470	0.6000036	46	14	7.6098566	12.3901434	46
15	7.6398160	9.9999959	2.3601840	0.0000041	45	15	7.6398201	12.3601799	45
16	7.6678445	9.9999953	2.3321555	0.0000047	44	16	7.6678492	12.3321508	44
17	7.6941733	9.9999947	2.3058267	0.0000053	43	17	7.6941786	12.3058214	43
18	7.7189966	9.9999940	2.2810034	0.0000059	42	18	7.7190026	12.2809974	42
19	7.7424775	9.9999934	2.2575225	0.0000066	41	19	7.7424841	12.2575159	41
20	7.7647537	9.9999927	2.2352463	0.0000073	40	20	7.7647610	12.2352390	40
21	7.7859427	9.9999919	2.2140573	0.0000081	39	21	7.7859508	12.2140492	39
22	7.8061458	9.9999911	2.1938542	0.0000089	38	22	7.8061547	12.1938453	38
23	7.8254507	9.9999903	2.1745493	0.0000097	37	23	7.8254604	12.1745396	37
24	7.8439338	9.9999894	2.1560662	0.0000106	36	24	7.8439444	12.1560556	36
25	7.8616623	9.9999885	2.1383377	0.0000115	35	25	7.8616738	12.1383262	35
26	7.8786953	9.9999876	2.1213047	0.0000124	34	26	7.8787077	12.1212923	34
27	7.8950854	9.9999866	2.1049146	0.0000134	33	27	7.8950988	12.1049012	33
28	7.9108793	9.9999856	2.0891207	0.0000144	32	28	7.9108938	12.0891062	32
29	7.9261190	9.9999845	2.0738810	0.0000155	31	29	7.9261344	12.0738656	31
30	7.9408419	9.9999835	2.0591581	0.0000165	30	30	7.9408584	12.0591416	30
31	7.9550819	9.9999823	2,0449181	0.0000177	29	31	7 9550996	12.0449004	29
32	7.9688698	9.9999812	2.0311302	0.0000188	28	32	7.9688886	12.0311114	28
33	7.9822334	9.9999800	2.0177666	0.0000200	27	33	7.9822534	12.0177466	27
34	7.9951980	9.9999738	2.0048020	0.0000212	26	34	7.9952192	12.0047808	26
35	8.0077867	9.9999775	1.9922133	0.0000225	25	35	8.0078092	12.9921908	25
36	8.0200207	9.9999762	1.9799793	0.0000238	24	36	8.0200445	11.9799555	24
37	8.0319195	9.9999748	1.9680805	0.0000252	23	37	8.0319446	11.9680554	23
38	8.0435009	9.9999735	1.9564991	0.0000265	22	38	8.0435274	11.9564726	22
39	8.0547814	9.9999721	1.9452186	0.0000279	21	39	8.0548193	11.9451806	21
40	8.0657763	9.9999706	1.9342237	0.0000294	20	40	8.0658057	11.9341943	20
41	8.0764997	9.9999691	1.9235003	0.0000309	19	41	8.0765306	11.9234694	19
42	8.0869646	9.9999676	1.9130354	0.0000324	18	42	8.0869970	11.9130030	18
43	8.0971832	9.9999660	1.9028168	0.0000340	17	43	8.0972172	11.9027828	17
44	8.1071669	9.9999644	1.8928331	0.0000356	16	44	8.1072025	11.8927975	16
45	8.1169262	9.9999628	1.8830738	0.0000372	15	45	8.1169634	11.8830366	15
46	8.1264710	9.9999611	1.8735290	0.0000389	14	46	8.1265099	11.8734901	14
47	8.1358104	9.9999594	1.8641896	0.0000406	13	47	8.1358510	11.8641490	13
48	8.1449532	9.9999577	1.8550468	0.0000423	12	48	8.1449956	11.8550044	12
49	8.1539075	9.9999559	1.8460925	0.0000441	11	49	8.1539516	11.8460484	11
50	8.1626808	9.9999541	1.8373192	0.0000459	10	50	8.1627367	11.8372633	10
51	8.1712804	9.9999522	1.8287196	0.0000478	9	51	8.1713282	11.8286718	9
52	8.1797129	9.9999503	1.8202871	0.0000497	8	52	8.1797626	11.8202374	8
53	8.1879848	9.9999484	1.8120152	0.0000516	7	53	8.1880364	11.8119636	7
54	8.1961020	9.9999464	1.8038980	0.0000536	6	54	8.1961556	11.8038444	6
55	8.2040703	9.9999444	1.7959297	0.0000556	5	55	8.2041259	11.7958741	5
56	8.2118949	9.9999424	1.7881051	0.0000576	4	56	8.2119526	11.7880474	4
57	8.2195811	9.9999403	1,7804189	0.0000597	3	57	8.2196408	11.7803592	3
58	8.2271335	9.9999382	1.7728665	0.0000618	2	58	8.2271953	11.7728047	2
59	8.2345[illegible]68	9.9999360	1.7654432	0.0000640	1	59	8.2346208	11.7653792	1
60	8.2418553	9.9999338	1.7581447	0.0000662	0	60	8.2419215	11.7580785	0
			Co. Arith.	Sign.				Tangent.	

D.	Sign.	Co. Arith.			
0	8.2418553	9.9999338	1.7581447	0.0000662	60
1	8.2490332	9.9999316	1.7509668	0.0000684	59
2	8.2560943	9.9999294	1.7439057	0.0000706	58
3	8.2630424	9.9999271	1.7369576	0.0000729	57
4	8.2698810	9.9999247	1.7301190	0.0000753	56
5	8.2766136	9.9999224	1.7233864	0.0000776	55
6	8.2832434	9.9999200	1.7167566	0.0000800	54
7	8.2897734	9.9999175	1.7102266	0.0000825	53
8	8.2962067	9.9999150	1.7037933	0.0000850	52
9	8.3025460	9.9999125	1.6974540	0.0000875	51
10	8.3087941	9.9999100	1.6912059	0.0000900	50
11	8.3149536	9.9999074	1.6850464	0.0000926	49
12	8.3210269	9.9999047	1.6789731	0.0000953	48
13	8.3270163	9.9999021	1.6729837	0.0000979	47
14	8.3329543	9.9998994	1.6670757	0.0001006	46
15	8.3387529	9.9998966	1.6612471	0.0001034	45
16	8.3445043	9.9998939	1.6554957	0.0001061	44
17	8.3501805	9.9998911	1.6498195	0.0001089	43
18	8.3557835	9.9998882	1.6442165	0.0001118	42
19	8.3613150	9.9998853	1.6386850	0.0001147	41
20	8.3667769	9.9998824	1.6332231	0.0001176	40
21	8.3721710	9.9998794	1.6278290	0.0001206	39
22	8.3774988	9.9998764	1.6225012	0.0001236	38
23	8.3827620	9.9998734	1.6172380	0.0001266	37
24	8.3879622	9.9998703	1.6120378	0.0001297	36
25	8.3931008	9.9998672	1.6068992	0.0001328	35
26	8.3981793	9.9998641	1.6018207	0.0001359	34
27	8.4031990	9.9998609	1.5968010	0.0001391	33
28	8.4081614	9.9998577	1.5918386	0.0001423	32
29	8.4130676	9.9998544	1.5869324	0.0001456	31
30	8.4179190	9.9998512	1.5820810	0.0001488	30
31	8.4227168	9.9998478	1.5772832	0.0001522	29
32	8.4274621	9.9998445	1.5725379	0.0001555	28
33	8.4321561	9.9998411	1.5678439	0.0001589	27
34	8.4367999	9.9998376	1.5632001	0.0001624	26
35	8.4413944	9.9998342	1.5586056	0.0001658	25
36	8.4459409	9.9998306	1.5540591	0.0001694	24
37	8.4504402	9.9998271	1.5495598	0.0001729	23
38	8.4548934	9.9998235	1.5451066	0.0001765	22
39	8.4598013	9.9998199	1.5406987	0.0001801	21
40	8.4636649	9.9998162	1.5363351	0.0001838	20
41	8.4670850	9.9998125	1.5320150	0.0001875	19
42	8.4722626	9.9998083	1.5277374	0.0001912	18
43	8.4764984	9.9998050	1.5235016	0.0001950	17
44	8.4806932	9.9998012	1.5193068	0.0001988	16
45	8.4848479	9.9997974	1.5151521	0.0002026	15
46	8.4889632	9.9997935	1.5110368	0.0002065	14
47	8.4930398	9.99978[illegible]6	1.5069602	0.0002104	13
48	8.4970784	9.9997856	1.5029216	0.0002144	12
49	8.5010798	9.9997817	1.4989202	0.0002183	11
50	8.5050447	9.9997776	1.4949553	0.0002224	10
51	8.5[illegible]89736	9.9997736	1.4910264	0.0002264	9
52	8.5128673	9.9997695	1.4871327	0.0002305	8
53	8.5167264	9.9997653	1.4832736	0.0002347	7
54	8.5205514	9.9997612	1.4794486	0.0002388	6
55	8.5243430	9.9997570	1.4756570	0.0002430	5
56	8.5281017	9.9997527	1.4718983	0.0002473	4
57	8.5318281	9.9997484	1.4681719	0.0002516	3
58	8.5355228	9.9997441	1.4644772	0.0002559	2
59	8.5391863	9.9997398	1.4608137	0.0002602	1
60	8.5428192	9.9997354	1.4571808	0.0002645	0
			Co. Arith.	Sign.	

	Tangent.		
0	8.2419215	11.7580785	60
1	8.2491015	11.7508985	59
2	8.2561649	11.7438351	58
3	8.2631153	11.7368847	57
4	8.2699563	11.7300437	56
5	8.2766912	11.7233083	55
6	8.2833234	11.7166766	54
7	8.2898559	11.7101441	53
8	8.2962917	11.7037083	52
9	8.3026335	11.6973665	51
10	8.3088842	11.6911158	50
11	8.3150462	11.6849538	49
12	8.3211221	11.6788779	48
13	8.3271143	11.6728857	47
14	8.3330249	11.6669751	46
15	8.3388563	11.6611437	45
16	8.3446105	11.6553895	44
17	8.3502895	11.6497105	43
18	8.3558953	11.6441047	42
19	8.3614297	11.6385703	41
20	8.3668945	11.6331055	40
21	8.3722915	11.6277085	39
22	8.3776223	11.6223777	38
23	8.3828886	11.6171114	37
24	8.3880918	11.6119082	36
25	8.3932336	11.6067664	35
26	8.3983152	11.6016848	34
27	8.4033381	11.5966619	33
28	8.4083037	11.5916963	32
29	8.4132132	11.5867868	31
30	8.4180679	11.5819321	30
31	8.4228690	11.5771310	29
32	8.4276176	11.5723824	28
33	8.4323150	11.5676850	27
34	8.4369622	11.5630378	26
35	8.4415603	11.5584397	25
36	8.4461103	11.5538897	24
37	8.4506131	11.5493869	23
38	8.4550699	11.5449301	22
39	8.4594814	11.5405186	21
40	8.4638486	11.5361514	20
41	8.4681725	11.5318275	19
42	8.4724538	11.5275462	18
43	8.4766933	11.5233067	17
44	8.4808920	11.5191080	16
45	8.4850505	11.5149495	15
46	8.4891696	11.5108304	14
47	8.4932502	11.5067498	13
48	8.4972928	11.5027072	12
49	8.5012982	11.4987018	11
50	8.5052671	11.4947329	10
51	8.5092001	11.4907999	9
52	8.5130978	11.4869022	8
53	8.5169610	11.4830387	7
54	8.5207902	11.4792098	6
55	8.5245860	11.4754140	5
56	8.5283490	11.4716510	4
57	8.5320797	11.4679203	3
58	8.5357787	11.4642213	2
59	8.5394466	11.4605534	1
60	8.5430838	11.4569162	0
		Tangent.	

Degrees 2.

D.	Sign.	Co. Arith.					Tangent.		
0	8.5428192	9.9997354	1.4571808	0.0002646	60	0	8.5430838	11.4569162	60
1	8.5464218	9.9997309	1.4535782	0.0002691	59	1	8.5466909	11.4533091	59
2	8.5499948	9.9997265	1.4500052	0.0002735	58	2	8.5502683	11.4497317	58
3	8.5535386	9.9997220	1.4464614	0.0002780	57	3	8.5538166	11.4461834	57
4	8.5570535	9.9997174	1.4429464	0.0002825	56	4	8.5573362	11.4426638	56
5	8.5605404	9.9997128	1.4394595	0.0002872	55	5	8.5608276	11.4391724	55
6	8.5639994	9.9997082	1.4360006	0.0002918	54	6	8.5642912	11.4357088	54
7	8.5674310	9.9997036	1.4325690	0.0002264	53	7	8.5677275	11.4322725	53
8	8.5708357	9.9996989	1.4291643	0.0003011	52	8	8.5711368	11.4288632	52
9	8.5742139	9.9996942	1.4257861	0.0003058	51	9	8.5745197	11.4254803	51
10	8.5775660	9.9996894	1.4224340	0.0003106	50	10	8.5778766	11.4221234	50
11	8.5808923	9.9996845	1.4191077	0.0003154	49	11	8.5812077	11.4187923	49
12	8.5841933	9.9996798	1.4158067	0.0003202	48	12	8.5845136	11.4154864	48
13	8.5874694	9.9996749	1.4125306	0.0003251	47	13	8.5877945	11.4122055	47
14	8.5907209	9.9996700	1.4092791	0.0003300	46	14	8.5910509	11.4089491	46
15	8.5939483	9.9996650	1.4060517	0.0003350	45	15	8.5942832	11.4057168	45
16	8.5971517	9.9996601	1.4028483	0.0003399	44	16	8.5974917	11.4025083	44
17	8.6003317	9.9996550	1.399 683	0.0003450	43	17	8.6006767	11.3993233	43
18	8.6034886	9.9996500	1.3965114	0.0003500	42	18	8.6038386	11.3961614	42
19	8.6066226	9.9996449	1.3933774	0.0003551	41	19	8.6069777	11.3930223	41
20	8.6097341	9.9996398	1.3902659	0.0003602	40	20	8.6100943	11.3899057	40
21	8.5128235	9.9996346	1.3871765	0.0003654	39	21	8.6131889	11.3868111	39
22	8.6158910	9.9996294	1.3841090	0.0003706	38	22	8.6162616	11.3837384	38
23	8.6189369	9.9996242	1.3810631	0.0003758	37	23	8.6193127	11.3806873	37
24	8.6219616	9.9996189	1.3780384	0.0003811	36	24	8.6223427	11.3776573	36
25	8.6249653	9.9996136	1.3750347	0.0003864	35	25	8.6253518	11.3746482	35
26	8.6279484	9.9996082	1.3720516	0.0003918	34	26	8.6283402	11.3716598	34
27	8.6309111	9.9996028	1.3690889	0.0003972	33	27	8.6313083	11.3686917	33
28	8.6338537	9.9995974	1.3661463	0.0004026	32	28	8.6342563	11.3657437	32
29	8.6367764	9.9995919	1.3632236	0.0004081	31	29	8.6371845	11.3628155	31
30	8.6396796	9.9995865	1.3603204	0.0004135	30	30	8.6400931	11.3599069	30
31	8.6425634	9.9995809	1.3574366	0.0004191	29	31	8.6429825	11.3570175	29
32	8.6454252	9.9995753	1.3545718	0.0004247	28	32	8.6458528	11.3541472	28
33	8.6482742	9.9995697	1.3517258	0.0004303	27	33	8.6487044	11.3512956	27
34	8.6511016	9.9995641	1.3488984	0.0004359	26	34	8.6515375	11.3484625	26
35	8.6539107	9.9995584	1.3460893	0.0004416	25	35	8.6543522	11.3456478	25
36	8.6567017	9.9995527	1.3432983	0.0004473	24	36	8.6571490	11.3428510	24
37	8.6594748	9.9995469	1.3405252	0.0004531	23	37	8.6599279	11.3400721	23
38	8.6622303	9.9995411	1.3377697	0.0004581	22	38	8.6626891	11.3373109	22
39	8.6649684	9.9995353	1.3350316	0.0004647	21	39	8.6654331	11.3345669	21
40	8.6676893	9.9995295	1.3323107	0.0004705	20	40	8.6681598	11.3318401	20
41	8.6703932	9.9995236	1.3296068	0.0004764	19	41	8.6708697	11.3291303	19
42	8.6730804	9.9995176	1.3269196	0.0004824	18	42	8.6735628	11.3264372	18
43	8.6757510	9.9995116	1.3242490	0.0004884	17	43	8.6762393	11.3237607	17
44	8.6784052	9.9995056	1.3215948	0.0004944	16	44	8.6788996	11.3211004	16
45	8.6810433	9.9994996	1.3189567	0.0005004	15	45	8.6815437	11.3184563	15
46	8.6836654	9.9994935	1.3163346	0.0005065	14	46	8.6841719	11.3158281	14
47	8.6862718	9.9994874	1.3137282	0.0005126	13	47	8.6867844	11.3132156	13
48	8.6888625	9.9994812	1.3111375	0.0005188	12	48	8.6893813	11.3106187	12
49	8.6914379	9.9994750	1.3085621	0.0005250	11	49	8.6919629	11.3080371	11
50	8.6939980	9.9994688	1.3060019	0.0005312	10	50	8.6945292	11.3054708	10
51	8.6965431	9.9994625	1.3034569	0.0005375	9	51	8.6970806	11.3029194	9
52	8.6990734	9.9994562	1.3009266	0.0005438	8	52	8.6996172	11.3003828	8
53	8.7015889	9.9994498	1.2984111	0.0005502	7	53	8.7021390	11.2978610	7
54	8.7040899	9.9994435	1.2959101	0.0005565	6	54	8.7046465	11.2953535	6
55	8.7065766	9.9994370	1.2934234	0.0005630	5	55	8.7071395	11.2928605	5
56	8.7090490	9.9994306	1.2909510	0.0005694	4	56	8.7096185	11.2903815	4
57	8.7115075	9.9994241	1.2884925	0.0005759	3	57	8.7120834	11.2879166	3
58	8.7139520	9.9994176	1.2860480	0.0005824	2	58	8.7145345	11.2854655	2
59	8.7163829	9.9994110	1.2836171	0.0005890	1	59	8.7169719	11.2830281	1
60	8.7188902	9.9994044	1.2811998	0.0005950	0	60	8.7193958	11.2806042	0
			Co. Arith.	Sign.				Tangent.	

Degrees 87.

D.	Sign.	Co. Arith.					Tangent.		
0	8.7188002	9.9994044	1.2811998	0.0005956	60	0	8.7193958	11.2806042	60
1	8.7212040	9.9993978	1.2787960	0.0006022	59	1	8.7218063	11.2781937	59
2	8.7335946	9.9993911	1.2764054	0.0006089	58	2	8.7242035	11.2757965	58
3	8.7259721	9.9993844	1.2740279	0.0006155	57	3	8.7265877	11.2734123	57
4	8.7283366	9.9993776	1.2716634	0.0006224	56	4	8.7289589	11.2710411	56
5	8.7306882	9.9993708	1.2693118	0.0006292	55	5	8.7313174	11.2686826	55
6	8.7330272	9.9993640	1.2669728	0.0006360	54	6	8.7336631	11.2663369	54
7	8.7353535	9.9993572	1.2646465	0.0006428	53	7	8.7359964	11.2640036	53
8	8.7376675	9.9993503	1.2623325	0.0006497	52	8	8.7383172	11.2616828	52
9	8.7399691	9.9993433	1.2600309	0.0006567	51	9	8.7406258	11.2593742	51
10	8.7422585	9.9993364	1.2577414	0.0006636	50	10	8.7429222	11.2570778	50
11	8.7445360	9.9993293	1.2554640	0.0006707	49	11	8.7452067	11.2547933	49
12	8.7468015	9.9993223	1.2531985	0.0006777	48	12	8.7474792	11.2525208	48
13	8.7490553	9.9993152	1.2509447	0.0006848	47	13	8.7497400	11.2502600	47
14	8.7512973	9.9993081	1.2487027	0.0006919	46	14	8.7519892	11.2480108	46
15	8.7535278	9.9993009	1.2464722	0.0006991	45	15	8.7542269	11.2457731	45
16	8.7557469	9.9992938	1.2442531	0.0007062	44	15	8.7564531	11.2435469	44
17	8.7579546	9.9992865	1.2420454	0.0007135	43	17	8.7586631	11.2413319	43
18	8.7601512	9.9992793	1.2398488	0.0007207	42	18	8.7608719	11.2391281	42
19	8.7623366	9.9992720	1.2376634	0.0007280	41	19	8.7630647	11.3369353	41
20	8.7645111	9.9992646	1.2354889	0.0007354	40	20	8.7652465	11.2347535	40
21	8.7666747	9.9992572	1.2333253	0.0007428	39	21	8.7674175	11.2325825	39
22	8.7688275	9.9992498	1.2311725	0.0007502	38	22	8.7695777	11.2304223	38
23	8.7709697	9.9992424	1.2290303	0.0007576	37	23	8.7717274	11.2282726	37
24	8.7731014	9.9992349	1.2268986	0.0007651	36	24	8.7738665	11.2261335	36
25	8.7752226	9.9992274	1.2247774	0.0007726	35	25	8.7759952	11.2240048	35
26	8.7773334	9.9992198	1.2226666	0.0007802	34	26	8.7781136	11.2218864	34
27	8.7794340	9.9992122	1.2205660	0.0007878	33	27	8.7802218	11.2197782	33
28	8.7815244	9.9992046	1.2184756	0.0007954	32	28	8.7823199	11.2176801	32
29	8.7836048	9.9991969	1.2163952	0.0008031	31	29	8.7844079	11.2155921	31
30	8.7856753	9.9991892	1.2143247	0.0008108	30	30	8.7864861	11.2135139	30
31	8.7877359	9.9991815	1.2122641	0.0008185	29	31	8.7885544	11.2114456	29
32	8.7897867	9.9991737	1.2102133	0.0008263	28	32	8.7906130	11.2093870	28
33	8.7918278	9.9991659	1.2081722	0.0008341	27	33	8.7926620	11.2073380	27
34	8.7938594	9.9991580	1.2061406	0.0008420	26	34	8.7947014	11.2052986	26
35	8.7958814	9.9991501	1.2041186	0.0008499	25	35	8.7907313	11.2032687	25
36	8.7978941	9.9991422	1.2021059	0.0008578	24	36	8.7987519	11.2012481	24
37	8.7998974	9.9991342	1.2001026	0.0008658	23	37	8.8007632	11.1992358	23
38	8.8018915	9.9991262	1.1981085	0.0008738	22	38	8.8027653	11.1972347	22
39	8.8038764	9.9991182	1.1961236	0.0008818	21	39	8.8047583	11.1952417	21
40	8.8058523	9.9991101	1.1941477	0.0008899	20	40	8.8067422	11.1932578	20
41	8.8078192	9.9991020	1.1921808	0.0008980	19	41	8.8607172	11.1912828	19
42	8.8097772	9.9990938	1.1902228	0.0009062	18	42	8.8106834	11.1893166	18
43	8.8117264	9.9990856	1.1882736	0.0009144	17	43	8.8126407	11.1873593	17
44	8.8136668	9.9990774	1.1863332	0.0009226	16	44	8.8145894	11.1854106	16
45	8.8155985	9.9990691	1.1844015	0.0009309	15	45	8.8165294	11.1834706	15
46	8.8175217	9.9990603	1.1824783	0.0009392	14	46	8.8184608	11.1815392	14
47	8.8194363	9.9990525	1.1805637	0.0009475	13	47	8.8203838	11.1796162	13
48	8.8213425	9.9990441	1.1786575	0.0009559	12	48	8.8222984	11.1777016	12
49	8.8232404	9.9990357	1.1767596	0.0009643	11	49	8.8242046	11.1757954	11
50	8.8251299	9.9990273	1.1748701	0.0009727	10	50	8.8261026	11.1738974	10
51	8.8270112	9.9990188	1.1729888	0.0009812	9	51	8.8279924	11.1720076	9
52	8.8288844	9.9990103	1.1711156	0.0009897	8	52	8.8298741	11.1701259	8
53	8.8307495	9.9990017	1.1692505	0.0009983	7	53	8.8317478	11.1682522	7
54	8.8326066	9.9989931	1.1673934	0.0010069	6	54	8.8336134	11.1663866	6
55	8.8344557	9.9989845	1.1655443	0.0010155	5	55	8.8354712	11.1645288	5
56	8.8362969	9.9989758	1.1637031	0.0010242	4	56	8.8373211	11.1626789	4
57	8.8381304	9.9989671	1.1618696	0.0010329	3	57	8.8391633	11.1608367	3
58	8.8399561	9.9989584	1.1600439	0.0010416	2	58	8.8409977	11.1590023	2
59	8.8417741	9.9989496	1.1582259	0.0010504	1	59	8.8428245	11.1571755	1
60	8.8435845	9.9989408	1.1564155	0.0010592	0	60	8.8446437	11.1553563	0
			Co. Arith.	Sign.				Tangent.	

D.	Sign.	Co. Arith.					Tangent.		
0	8.8435845	9.9989408	1.1564155	0.0010592	60	0	8.8446437	11.1553563	60
1	8.8453874	9.9989319	1.1546126	0.0010681	59	1	8.8464554	11.1535446	59
2	8.8471827	9.9989230	1.1528173	0.0010770	58	2	8.8482597	11.1517403	58
3	8.8489707	9.9989141	1.1510293	0.0010859	57	3	8.8500566	11.1499434	57
4	8.8507512	9.9989052	1.1492488	0.0010948	56	4	8.8518461	11.1481539	56
5	8.8525245	9.9988962	1.1474755	0.0011038	55	5	8.8536283	11.1463717	55
6	8.8542905	9.9988871	1.1457095	0.0011129	54	6	8.8554034	11.1445966	54
7	8.8560493	9.9988780	1.1439507	0.0011220	53	7	8.8571713	11.1428287	53
8	8.8578010	9.9983689	1.1421990	0.0011311	52	8	8.8589321	11.1410679	52
9	8.8595457	9.9988598	1.1404543	0.0011402	51	9	8.8606859	11.1393141	51
10	8.8612833	9.9988506	1.1387167	0.0011494	50	10	8.8624327	11.1375673	50
11	8.8630139	9.9988414	1.1369861	0.0011586	49	11	8.8641725	11.1358275	49
12	8.8647376	9.9988321	1.1352624	0.0011679	48	12	8.8659055	11.1340945	48
13	8.8664545	9.9988228	1.1335455	0.0011772	47	13	8.8676317	11.1323683	47
14	8.8681646	9.9988135	1.1318354	0.0011865	46	14	8.8693511	11.1306489	46
15	8.8698680	9.9988041	1.1301320	0.0011959	45	15	8.8710638	11.1289362	45
16	8.8715646	9.9987947	1.1284354	0.0012053	44	16	8.8727699	11.1272301	44
17	8.8732546	9.9987853	1.1267454	0.0012147	43	17	8.8744694	11.1255306	43
18	8.8749381	9.9987758	1.1250619	0.0012242	42	18	8.8761623	11.1238377	42
19	8.8766150	9.9987663	1.1233850	0.0012337	41	19	8.8778487	11.1221513	41
20	8.8782854	9.9987567	1.1217146	0.0012433	40	20	8.8795286	11.1204714	40
21	8.8799493	9.9987471	1.1200507	0.0012529	39	21	8.8812022	11.1187978	39
22	8.8816069	9.9987375	1.1183931	0.0012625	38	22	8.8828694	11.1171306	38
23	8.8832581	9.9987278	1.1167419	0.0012722	37	23	8.8845303	11.1154697	37
24	8.8849031	9.9987181	1.1150969	0.0012819	36	24	8.8861850	11.1138150	36
25	8.8865418	9.9987084	1.1134582	0.0012916	35	25	8.8878334	11.1121666	35
26	8.8881743	9.9986986	1.1118257	0.0013014	34	26	8.8894757	11.1105243	34
27	8.8898007	9.9986888	1.1101993	0.0013112	33	27	8.8911119	11.1088881	33
28	8.8914209	9.9986790	1.1085791	0.0013210	32	28	8.8927420	11.1072580	32
29	8.8930351	9.9986691	1.1069649	0.0013309	31	29	8.8943660	11.1056340	31
30	8.8946433	9.9986591	1.1053567	0.0013409	30	30	8.8959842	11.1040158	30
31	8.8962455	9.9986492	1.1037545	0.0013508	29	31	8.8975963	11.1024037	29
32	8.8978418	9.9986392	1.1021582	0.0013608	28	32	8.8992026	11.1007974	28
33	8.8994322	9.9986292	1.1005678	0.0013708	27	33	8.9008030	11.0991970	27
34	8.9010168	9.9986191	1.0989832	0.0013809	26	34	8.9023977	11.0976023	26
35	8.9025955	9.9986090	1.0974045	0.0013910	25	35	8.9039866	11.0960134	25
36	8.9041685	9.9985988	1.0958315	0.0014012	24	36	8.9055697	11.0944303	24
37	8.9057358	9.9985886	1.0942642	0.0014114	23	37	8.9071472	11.0928528	23
38	8.9072975	9.9985784	1.0927025	0.0014216	22	38	8.9087190	11.0812810	22
39	8.9088535	9.9985682	1.0911465	0.0014318	21	39	8.9102853	11.0897147	21
40	8.9104039	9.9985579	1.0895961	0.0014421	20	40	8.9118460	11.0881540	20
41	8.9119478	9.9985475	1.0880513	0.0014525	19	41	8.9134012	11.0865988	19
42	8.9134880	9.9985372	1.0865119	0.0014628	18	42	8.9149509	11.0850491	18
43	8.9150219	9.9985268	1.0849781	0.0014732	17	43	8.9164952	11.0835048	17
44	8.9165504	9.9985163	1.0834496	0.0014837	16	44	8.9180340	11.0819660	16
45	8.9180734	9.9985058	1.0819266	0.0014942	15	45	8.9195675	11.0804325	15
46	8.9195911	9.9984953	1.0804089	0.0015047	14	46	8.9210957	11.0789043	14
47	8.9211034	9.9984848	1.0788966	0.0015152	13	47	8.9226186	11.0773814	13
48	8.9226105	9.9984742	1.0773895	0.0025258	12	48	8.9241393	11.0758637	12
49	8.9241123	9.9984636	1.0758877	0.0015364	11	49	8.9256487	11.0743513	11
50	8.9256089	9.9984529	1.0743911	0.0015471	10	50	8.9271560	11.0728440	10
51	8.9271003	9.9984422	1.0728997	0.0015578	9	51	8.9386581	11.0713419	9
52	8.9285866	9.9984315	1.0714134	0.0015685	8	52	8.9301552	11.0698448	8
53	8.9300678	9.9984207	1.0699322	0.0015793	7	53	8.9316471	11.0683529	7
54	8.9315439	9.9984099	1.0684561	0.0015901	6	54	8.9331340	11.0668660	6
55	8.9330150	9.9983990	1.0669850	0.0016010	5	55	8.9346160	11.0653840	5
56	8.9344811	9.9983881	1.0655189	0.0016119	4	56	8.9360929	11.0639071	4
57	8.9359422	9.9983772	1.0640578	0.0016228	3	57	8.9375650	11.0624350	3
58	8.9373983	9.9983663	1.0626017	0.0016337	2	58	8.9390321	11.0609679	2
59	8.9388496	9.9983553	1.0611504	0.0016447	1	59	8.9404944	11.0595056	1
60	8.9402960	9.9983442	1.0597040	0.0016558	0	60	8.9419518	11.0580482	0
			Co. Arith.	Sign.				Tangent.	

Degrees 5.

M.	Sign.	Co. Arith.					Tangent.		
0	8.9402960	9.9983442	1.0597040	0.0016558	60	0	8.9419518	11.0580482	60
1	8.9417376	9.9983331	1.0582624	0.0016668	59	1	8.9434044	11.0565956	59
2	8.9431743	9.9983220	1.0568257	0.0016780	58	2	8.9448523	11.0551477	58
3	8.9446063	9.9983109	1.0553937	0.0016891	57	3	8.9462954	11.0537046	57
4	8.9460335	9.9982997	1.0536965	0.0017003	56	4	8.9477338	11.0522662	56
5	8.9474561	9.9982885	1.0525439	0.0017115	55	5	8.9491676	11.0508324	55
6	8.9488739	9.9982772	1.0511261	0.0017228	54	6	8.9505967	11.0494033	54
7	8.9502871	9.9982660	1.0497129	0.0017340	53	7	8.9520211	11.0479789	53
8	8.9516957	9.9982546	1.0483043	0.0017454	52	8	8.9534410	11.0465590	52
9	8.9536996	9.9982433	1.0469004	0.0017567	51	9	8.9548564	11.0451436	51
10	8.9544991	9.9982318	1.0455009	0.0017682	50	10	8.9562672	11.0437328	50
11	8.9558940	9.9982204	1.0441060	0.0017796	49	11	8.9576735	11.0423265	49
12	8.9572843	9.9982089	1.0427157	0.0017911	48	12	8.9590754	11.0409246	48
13	8.9586703	9.9981974	1.0413297	0.0018026	47	13	8.9604728	11.0395272	47
14	8.9600517	9.9981859	1.0399483	0.0018141	46	14	8.9618659	11.0381341	46
15	8.9614288	9.9981743	1.0385712	0.0018257	45	15	8.9632545	11.0367455	45
16	8.9628014	9.9981626	1.0371986	0.0018374	44	16	8.9646388	11.0353612	44
17	8.9641697	9.9981510	1.0358303	0.0018490	43	17	8.9660188	11.0339812	43
18	8.9655337	9.9981393	1.0344663	0.0018607	42	18	8.9673944	11.0326056	42
19	8.9668934	9.9981275	1.0331066	0.0018725	41	19	8.9687758	11.0312342	41
20	8.9682487	9.9981158	1.0317513	0.0018842	40	20	8.9701330	11.0298670	40
21	8.9695999	9.9981040	1.0304001	0.0018960	39	21	8.9714959	11.0285041	39
22	8.9709468	9.9980921	1.0290532	0.0019079	38	22	8.9728547	11.0271453	38
23	8.9722895	9.9980802	1.0277105	0.0019198	37	23	8.9742092	11.0257908	37
24	8.9736280	9.9980683	1.0263720	0.0019317	36	24	8.9755597	11.0244403	36
25	8.9749624	9.9980563	1.0250376	0.0019437	35	25	8.9769060	11.0230940	35
26	8.9762926	9.9980443	1.0237074	0.0019557	34	26	8.9782483	11.0217517	34
27	8.9776188	9.9980323	1.0223812	0.0019677	33	27	8.9795865	11.0204135	33
28	8.9789408	9.9980202	1.0210592	0.0019798	32	28	8.9809206	11.0190794	32
29	8.9802589	9.9980081	1.0197411	0.0019919	31	29	8.9822507	11.0177493	31
30	8.9815729	9.9979960	1.0184271	0.0020040	30	30	8.9835769	11.0164231	30
31	8.9828829	9.9979838	1.0171171	0.0020162	29	31	8.9948991	11.0151009	29
32	8.9841889	9.9979716	1.0158111	0.0020284	28	32	8.9962173	11.0137827	28
33	8.9854910	9.9979593	1.0145090	0.0020407	27	33	8.9975317	11.0124683	27
34	8.9867891	9.9979470	1.0132109	0.0020530	26	34	8.9988421	11.0111579	26
35	8.9880834	9.9979347	1.0119166	0.0020653	25	35	8.9901487	11.0098513	25
36	8.9893737	9.9979223	1.0106263	0.0020777	24	36	8.9914514	11.0085486	24
37	8.9906602	9.9979099	1.0093398	0.0920901	23	37	8.9927503	11.0072497	23
38	8.9919429	9.9978975	1.0080571	0.0021025	22	38	8.9940454	11.0059546	22
39	8.9932217	9.9978850	1.0067783	0.0021150	21	39	8.9953367	11.0046636	21
40	8.9944968	9.9978725	1.0055032	0.0021275	20	40	8.9966243	11.0033757	20
41	8.9957681	9.9978599	1.0042319	0.0021401	19	41	8.9979081	11.0020919	16
42	8.9970356	9.9978473	1.0029644	0.0021527	18	42	8.9991883	11.0008117	18
43	8.9982994	9.9978347	1.0017006	0.0021653	17	43	9.0004647	10.9995353	17
44	8.9995595	9.9978220	1.0004405	0.0021780	16	44	9.0017375	10.9982625	16
45	9.0008160	9.9978093	0.9991840	0.0021907	15	45	9.0030066	10.9969934	15
46	9.0020687	9.9977966	0.9979313	0.0022034	14	46	9.0042721	10.9957279	14
47	9.0033179	9.9977838	0.9966821	0.0022162	13	47	9.0055340	10.9944660	13
48	9.0045634	9.9977710	0.9954366	0.0022290	12	48	9.0067924	10.9932076	12
49	9.0058053	9.9977582	0.9941947	0.0022418	11	49	9.0080471	10.9919529	11
50	9.0070436	9.9977453	0.9929564	0.0022547	10	50	9.0092984	10.9907016	10
51	9.0082784	9.9977323	0.9917216	0.0022677	9	51	9.0105461	10.9894539	9
52	9.0095096	9.9977194	0.9904904	0.0022806	8	52	9.0117903	10.9882097	8
53	9.0107374	9.9977064	0.9892626	0.0022936	7	53	9.0130310	10.9869690	7
54	9.0119616	9.9976933	0.9880384	0.0023067	6	54	9.0142682	10.9857318	6
55	9.0131823	9.9976803	0.9868177	0.0023197	5	55	9.0155021	10.9844979	5
56	9.0143996	9.9976672	0.9856004	0.0023328	4	56	9.0167325	10.9832675	4
57	9.0156135	9.9976540	0.9843865	0.0023460	3	57	9.0179594	10.9820406	3
58	9.0168239	9.9976408	0.9831761	0.0023592	2	58	9.0191831	10.9808169	2
59	9.0180309	9.9976276	0.9819691	0.0023724	1	59	9.0204033	10.9795967	1
60	9.0192346	9.9976143	0.9807654	0.0023857	0	60	9.0216202	10.9783798	0
			Co. Arith.	Sign.				Tangent.	

Degrees 84.

Degrees 6.

M.	Sign.	Co. Arith.					Tangent.		
0	9.0192346	9.9976143	0.9807654	0.0023857	60	0	9.0216202	10.9783798	60
1	9.0204343	9.9976011	0.9795652	0.0023989	59	1	9.0228338	10.9771662	59
2	9.0216318	9.9975877	0.9783682	0.0024123	58	2	9.0240441	10.9759559	58
3	9.0228254	9.9975743	0.9771746	0.0024257	57	3	9.0252510	10.9747490	57
4	9.0240157	9.9975609	0.9759843	0.0024391	56	4	9.0264548	10.9735452	56
5	9.0252027	9.9975475	0.9747973	0.0024525	55	5	9.0276552	10.9723448	55
6	9.0263865	9.9975340	0.9736135	0.0024660	54	6	9.0288524	10.9711476	54
7	9.0275669	9.9975205	0.9724331	0.0024795	53	7	9.0300464	10.9699536	53
8	9.0287442	9.9975069	0.9712558	0.0024931	52	8	9.0312373	10.9687627	52
9	9.0299182	9.9974933	0.9700818	0.0025067	51	9	9.0324249	10.9675751	51
10	9.0310890	9.9974797	0.9689110	0.0025203	50	10	9.0336093	10.9663907	50
11	9.0322567	9.9974660	0.9677433	0.0025340	49	11	9.0347906	10.9652094	49
12	9.0334212	9.9974523	0.9665788	0.0025477	48	12	9.0359688	10.9640312	48
13	9.0345825	9.9974386	0.9654175	0.0025614	47	13	9.0371439	10.9628561	47
14	9.0357407	9.9974248	0.9642593	0.0025752	46	14	9.0383159	10.9616841	46
15	9.0368958	9.9974110	0.9631042	0.0025890	45	15	9.0394848	10.9605152	45
16	9.0380477	9.9973971	0.9619523	0.0026029	44	16	9.0406505	10.9593494	44
17	9.0391966	9.9973832	0.9608034	0.0026167	43	17	9.0418134	10.9581866	43
18	9.0403424	9.9973693	0.9596575	0.0026307	42	18	9.0429731	10.9570269	42
19	9.0414852	9.9973554	0.9585148	0.0026446	41	19	9.0441299	10.9558701	41
20	9.0426249	9.9973414	0.9573751	0.0026586	40	20	9.0452836	10.9547164	40
21	9.0437617	9.9973273	0.9562383	0.0026727	39	21	9.0464343	10.9535657	39
22	9.0448954	9.9973132	0.9551046	0.0026868	38	22	9.0475821	10.9524179	38
23	9.0460261	9.9972991	0.9539739	0.0027009	37	23	9.0487270	10.9512730	37
24	9.0471538	9.9972850	0.9528462	0.0027150	36	24	9.0498689	10.9501311	36
25	9.0482786	9.9972708	0.9517214	0.0027292	35	25	9.0510078	10.9489922	35
26	9.0494005	9.9972566	0.9505995	0.0027434	34	26	9.0521439	10.9478561	34
27	9.0505194	9.9972423	0.9494806	0.0027577	33	27	9.0532771	10.9467229	33
28	9.0516354	9.9972280	0.9483646	0.0027720	32	28	9.0544074	10.9455926	32
29	9.0527485	9.9972137	0.9472515	0.0027863	31	29	9.0555349	10.9444651	31
30	9.0538588	9.9971993	0.9461412	0.0028007	30	30	9.0566595	10.9433405	30
31	9.0549661	9.9971849	0.9450339	0.0028151	29	31	9.0577813	10.9422187	29
32	9.0560706	9.9971704	0.9439294	0.0028296	28	32	9.0589002	10.9410998	28
33	9.0571723	9.9971559	0.9428277	0.0028441	27	33	9.0600164	10.9399836	27
34	9.0582711	9.9971414	0.9417289	0.0028586	26	34	9.0611297	10.9388703	26
35	9.0593672	9.9971268	0.9406328	0.0028732	25	35	9.0622403	10.9377597	25
36	9.0604604	9.9971122	0.9395396	0.0028878	24	36	9.0633482	10.9366518	24
37	9.0615509	9.9970975	0.9384491	0.0029024	23	37	9.0644533	10.9355467	23
38	9.0626386	9.9970829	0.9373614	0.0029171	22	38	9.0655556	10.9344444	22
39	9.0637235	9.9970682	0.9362765	0.0029318	21	39	9.0666553	10.9333447	21
40	9.0648057	9.9970535	0.9351943	0.0029465	20	40	9.0677522	10.9322478	20
41	9.0658852	9.9970387	0.9341148	0.0029613	19	41	9.0688455	10.9311535	19
42	9.0669619	9.9970239	0.9330381	0.0029761	18	42	9.0699381	10.9300619	18
43	9.0680360	9.9970090	0.9319640	0.0029910	17	43	9.0710270	10.9289730	17
44	9.0691074	9.9969941	0.9308926	0.0030059	16	44	9.0721133	10.9278867	16
45	9.0701761	9.9969792	0.9298239	0.0030208	15	45	9.0731969	10.9268031	15
46	9.0712421	9.9969642	0.9287579	0.0030358	14	46	9.0742779	10.9257221	14
47	9.0723055	9.9969492	0.9276945	0.0030508	13	47	9.0753563	10.9246437	13
48	9.0733663	9.9969342	0.9266337	0.0030658	12	48	9.0764321	10.9235679	12
49	9.0744244	9.9969191	0.9255756	0.0030809	11	49	9.0775053	10.9224947	11
50	9.0754799	9.9969040	0.9245201	0.0030960	10	50	9.0785760	10.9214240	10
51	9.0765328	9.9968888	0.9234671	0.0031112	9	51	9.0796441	10.9203559	9
52	9.0775832	9.9968736	0.9224168	0.0031264	8	52	9.0807096	10.9192904	8
53	9.0786310	9.9968584	0.9213690	0.0031416	7	53	9.0817726	10.9182274	7
54	9.0796762	9.9968431	0.9203238	0.0031569	6	54	9.0828331	10.9171669	6
55	9.0807189	9.9968278	0.9192811	0.0031722	5	55	9.0838911	10.9161089	5
56	9.0817590	9.9968125	0.9182410	0.0031875	4	56	9.0849466	10.9150534	4
57	9.0827966	9.9967971	0.9172034	0.0032029	3	57	9.0859996	10.9140004	3
58	9.0838317	9.9967817	0.9161683	0.0032183	2	58	9.0870501	10.9129499	2
59	9.0848643	9.9967662	0.9151357	0.0032338	1	59	9.0880931	10.9119019	1
60	9.0858945	9.9967507	0.9141055	0.0032493	0	60	9.0891438	10.9108562	0
M.			Co. Arith.	Sign.				Tangent.	

Degrees 84.

M.	Sign.	Co. Arith.					Tangent.		
0	9.0858945	9.9967507	0.9141055	0.0032493	60	0	9.0891438	10.9108562	60
1	9.0869221	9.9967352	0.9130779	0.0032648	59	1	9.0901869	10.9098131	59
2	9.0879473	9.9967196	0.9120528	0.0032805	58	2	9.0912277	10.9087723	58
3	9.0889700	9.9967040	0.9110307	0.0032960	57	3	9.0922660	10.9077340	57
4	9.0899903	9.9966884	0.9100097	0.0033116	56	4	9.0933020	10.9066980	56
5	9.0910082	9.9966727	0.9089918	0.0033273	55	5	9.0943355	10.9056645	55
6	9.0920237	9.9966570	0.9079763	0.0033430	54	6	9.0953667	10.9046333	54
7	9.0930367	9.9966412	0.9069633	0.0033588	53	7	9.0963955	10.9036045	53
8	9.0940474	9.9966254	0.9059526	0.0033746	52	8	9.0974219	10.9025781	52
9	9.0950556	9.9966096	0.9049444	0.0033904	51	9	9.0984460	10.9015540	51
10	9.0960615	9.9965937	0.9039385	0.0034063	50	10	9.0994678	10.9005322	50
11	9.0970651	9.9965778	0.9029349	0.0034222	49	11	9.1004872	10.8995128	49
12	9.0980662	9.9965619	0.9019338	0.0034381	48	12	9.1015044	10.8984956	48
13	9.0990651	9.9965459	0.9009349	0.0034541	47	13	9.1025192	10.8974808	47
14	9.1000616	9.9965299	0.8999384	0.0034701	46	14	9.1035317	10.8964683	46
15	9.1010558	9.9965138	0.8989442	0.0034862	45	15	9.1045420	10.8954580	45
16	9.1020477	9.9964977	0.8979523	0.0035022	44	16	9.1055500	10.8944500	44
17	9.1030373	9.9964816	0.8969627	0.0035184	43	17	9.1065557	10.8934443	43
18	9.1040246	9.9964655	0.8959754	0.0035345	42	18	9.1075591	10.8924409	42
19	9.1050090	9.9964493	0.8949904	0.0035507	41	19	9.1085604	10.8914396	41
20	9.1059924	9.9964330	0.8940076	0.0035670	40	20	9.1095594	10.8904406	40
21	9.1069729	9.9964167	0.8930271	0.0035833	39	21	9.1105562	10.8894438	39
22	9.1079512	9.9964004	0.8920488	0.0035996	38	22	9.1115508	10.8884492	38
23	9.1089272	9.9963841	0.8910728	0.0036159	37	23	9.1125431	10.8874569	37
24	9.1099010	9.9963677	0.8900990	0.0036323	36	24	9.1135333	10.8864667	36
25	9.1108726	9.9963513	0.8891274	0.0036487	35	25	9.1145213	10.8854787	35
26	9.1118420	9.9963348	0.8881580	0.0036652	34	26	9.1155072	10.8844928	34
27	9.1128092	9.9963183	0.8871908	0.0036817	33	27	9.1164909	10.8835091	33
28	9.1137742	9.9963018	0.8862258	0.0036982	32	28	9.1174724	10.8825276	32
29	9.1147370	9.9962852	0.8852630	0.0037148	31	29	9.1184518	10.8815482	31
30	9.1156977	9.9962686	0.8843023	0.0037314	30	30	9.1194291	10.8805709	30
31	9.1166562	9.9962519	0.8833438	0.0037481	29	31	9.1204043	10.8795957	29
32	9.1176125	9.9962352	0.8823875	0.0037648	28	32	9.1213773	10.8786227	28
33	9.1185667	9.9962185	0.8814332	0.0037815	27	33	9.1223482	10.8776518	27
34	9.1195188	9.9962017	0.8804812	0.0037983	26	34	9.1233171	10.8766829	26
35	9.1204688	9.9961849	0.8795312	0.0038151	25	35	9.1242839	10.8757161	25
36	9.1214167	9.9961681	0.8785833	0.0038319	24	36	9.1252486	10.8747514	24
37	9.1223624	9.9961512	0.8776376	0.0038488	23	37	9.1262112	10.8737888	23
38	9.1233061	9.9961343	0.8766939	0.0038657	22	38	9.1271718	10.8728282	22
39	9.1242417	9.9961177	0.8757523	0.0038826	21	39	9.1281303	10.8718697	21
40	9.1251872	9.9961004	0.8748128	0.0038996	20	40	9.1290868	10.8709132	20
41	9.1261246	9.9960834	0.8738754	0.0039166	19	41	9.1300413	10.8699587	19
42	9.1270600	9.9950663	0.8729400	0.0039337	18	42	9.1309937	10.8690063	18
43	9.1279934	9.9960492	0.8720066	0.0039508	17	43	9.1319442	10.8680558	17
44	9.1289247	9.9960321	0.8710753	0.0039679	16	44	9.1328926	10.8671074	16
45	9.1298539	9.9960149	0.8701461	0.0039851	15	45	9.1338391	10.8661609	15
46	9.1307812	9.9959977	0.8692188	0.0040023	14	46	9.1347835	10.8652165	14
47	9.1317064	9.9959804	0.8682936	0.0040196	13	47	9.1357260	10.8642740	13
48	9.1326297	9.9959631	0.8673703	0.0040369	12	48	9.1366665	10.8633335	12
49	9.1335509	9.9959458	0.8664491	0.0040542	11	49	9.1376051	10.8623949	11
50	9.1344702	9.9959284	0.8655298	0.0040716	10	50	9.1385417	10.8614583	10
51	9.1353875	9.9959111	0.8646125	0.0040889	9	51	9.1394764	10.8505236	9
52	9.1363028	9.9958936	0.8636972	0.0041064	8	52	9.1404092	10.8595908	8
53	9.1372161	9.9958761	0.8627839	0.0041239	7	53	9.1413400	10.8586600	7
54	9.1381275	9.9958586	0.8618725	0.0041414	6	54	9.1422689	10.8577311	6
55	9.1390370	9.9958411	0.8609630	0.0041589	5	55	9.1431959	10.8568041	5
56	9.1399445	9.9958235	0.8600555	0.0041765	4	56	9.1441210	10.8558790	4
57	9.1408501	9.9958059	0.8591499	0.0041941	3	57	9.1450442	10.8549558	3
58	9.1417537	9.9957882	0.8582463	0.0042118	2	58	9.1459655	10.8540346	2
59	9.1426555	9.9957705	0.8573445	0.0042295	1	59	9.1468850	10.8531150	1
60	9.1435553	9.9957528	0.8564447	0.0042472	0	60	9.1478025	10.8531975	0
			Co. Arith.	Sign.				Tangent.	

Degrees 8.

M.	Sign.	Co. Arith.					Tangent.		
0	9.1435553	9.9957528	0.8564447	0.0042472	60	0	9.1478025	10.8521975	60
1	9.1444532	9.9957350	0.8555468	0.0042650	59	1	9.1487182	10.8512818	59
2	9.1453493	9.9957172	0.8546507	0.0042828	58	2	9.1496321	10.8503679	58
3	9.1462435	9.9956993	0.8537565	0.0043007	57	3	9.1505441	10.8494559	57
4	9.1471358	9.9956815	0.8528642	0.0043185	56	4	9.1514543	10.8485457	56
5	9.1480262	9.9956635	0.8519738	0.0043365	55	5	9.1523627	10.8476373	55
6	9.1489148	9.9956456	0.8510852	0.0043544	54	6	9.1532692	10.8467308	54
7	9.1498015	9.9956276	0.8501985	0.0043724	53	7	9.1541739	10.8458261	53
8	9.1506864	9.9956095	0.8493136	0.0043905	52	8	9.1550769	10.8449231	52
9	9.1515694	9.9955915	0.8484306	0.0044085	51	9	9.1559780	10.8440220	51
10	9.1524507	9.9955734	0.8475493	0.0044266	50	10	9.1568773	10.8431227	50
11	9.1533301	9.9955552	0.8466699	0.0044448	49	11	9.1577748	10.8422252	49
12	9.1542076	9.9955370	0.8457924	0.0044630	48	12	9.1586705	10.8413294	48
13	9.1550834	9.9955188	0.8449166	0.0044812	47	13	9.1595546	10.8404354	47
14	9.1559574	9.9955005	0.8440426	0.0044995	46	14	9.1604569	10.8395431	46
15	9.1568296	9.9954822	0.8431704	0.0045178	45	15	9.1613373	10.8386527	45
16	9.1577000	9.9954639	0.8423000	0.0045361	44	16	9.1623361	10.8377539	44
17	9.1585686	9.9954455	0.8414314	0.0045545	43	17	9.1631231	10.8368769	43
18	9.1594354	9.9954271	0.8405646	0.0045729	42	18	9.1640083	10.8359917	42
19	9.1603005	9.9955087	0.8396995	0.0045913	41	19	9.1648919	10.8351081	41
20	9.1611639	9.9953902	0.8388361	0.0046098	40	20	9.1657737	10.8342263	40
21	9.1620254	9.9953717	0.8379746	0.0046283	39	21	9.1656538	10.8333462	39
22	9.1628853	9.9953531	0.8371147	0.0046469	38	22	9.1675322	10.8324678	38
23	9.1637434	9.9953345	0.8362566	0.0046655	37	23	9.1684089	10.8315911	37
24	9.1645998	9.9953159	0.8354002	0.0046841	36	24	9.1692839	10.8307161	36
25	9.1654544	9.9952972	0.8345456	0.0047028	35	25	9.1701572	10.8298428	35
26	9.1663074	9.9952785	0.8336926	0.0047215	34	26	9.1710289	10.8289711	34
27	9.1671586	9.9952597	0.8328414	0.0047403	33	27	9.1718989	10.8281011	33
28	9.1680081	9.9952409	0.8319919	0.0047591	32	28	9.1727672	10.8272328	32
29	9.1688559	9.9952221	0.8311441	0.0047779	31	29	9.1736338	10.8263662	31
30	9.1697021	9.9952033	0.8302979	0.0047967	30	30	9.1744988	10.8255012	30
31	9.1705465	9.9951844	0.8294535	0.0048156	29	31	9.1753622	10.8246378	29
32	9.1713893	9.9951654	0.8286107	0.0048346	28	32	9.1762239	10.8237761	28
33	9.1722305	9.9951464	0.8277695	0.0048536	27	33	9.1770840	10.8229160	27
34	9.1730699	9.9951274	0.8269301	0.0048726	26	34	9.1779425	10.8220575	26
35	9.1739077	9.9951084	0.8260923	0.0048916	25	35	9.1787993	10.8212007	25
36	9.1747439	9.9950893	0.8252561	0.0049107	24	36	9.1796546	10.8203454	24
37	9.1755784	9.9950702	0.8244216	0.0049298	23	37	9.1805082	10.8194918	23
38	9.1767112	9.9950510	0.8235888	0.0049490	22	38	9.1813602	10.8186398	22
39	9.1772425	9.9950318	0.8227575	0.0045682	21	39	9.1822107	10.8177894	21
40	9.1780721	9.9950126	0.8219279	0.0049874	20	40	9.1830595	10.8169405	20
41	9.1789001	9.9949933	0.8210999	0.0050067	19	41	9.1839068	10.8160932	19
42	9.1797265	9.9949740	0.8202735	0.0050260	18	42	9.1847525	10.8152475	18
43	9.1805512	9.9949546	0.8194488	0.0050454	17	43	9.1855966	10.8144034	17
44	9.1813744	9.9949352	0.8186256	0.0050648	16	44	9.1864392	10.8135608	16
45	9.1821960	9.9949158	0.8178040	0.0050842	15	45	9.1872802	10.8127198	15
46	9.1830160	9.9948964	0.8169840	0.0051036	14	46	9.1881196	10.8118804	14
47	9.1838344	9.9948769	0.8161656	0.0051231	13	47	9.1889575	10.8110425	13
48	9.1846512	9.9948573	0.8153488	0.0051427	12	48	9.1897939	10.8102061	12
49	9.1854665	9.9948377	0.8145335	0.0051623	11	49	9.1906287	10.8093713	11
50	9.1862802	9.9948181	0.8137198	0.0051819	10	50	9.1914621	10.8085379	10
51	9.1870923	9.9947985	0.8129077	0.0052015	9	51	9.1922939	10.8077061	9
52	9.1879029	9.9947788	0.8120971	0.0052212	8	52	9.1931241	10.8068759	8
53	9.1887120	9.9947591	0.8112880	0.0052409	7	53	9.1939529	10.8060471	7
54	9.1895195	9.9947393	0.8104805	0.0052607	6	54	9.1947802	10.8052198	6
55	9.1903254	9.9947195	0.8096746	0.0052805	5	55	9.1956059	10.8043941	5
56	9.1911399	9.9946997	0.8088701	0.0053003	4	56	9.1964402	10.8035598	4
57	9.1919328	9.9946798	0.8080672	0.0053202	3	57	9.1972530	10.8027470	3
58	9.1927342	9.9946599	0.8072658	0.0053401	2	58	9.1980743	10.8019557	2
59	9.1935341	9.9946399	0.8064659	0.0053601	1	59	9.1988941	10.8011059	1
60	9.1943324	9.9946199	0.8056676	0.0053861	0	60	9.1997125	10.8002875	0
			Co. Arith.	Sign.				Tangent.	

Degrees 81.

Degrees 9.

M.	Sign.	Co. Arith.					Tangent.		
0	9.1943324	9.9946199	0.8056676	0.0053801	60	0	9.1997125	10.8002875	60
1	9.1951293	9.9945999	0.8048707	0.0054001	59	1	9.2005294	10.7994706	59
2	9.1959247	9.9945798	0.8040753	0.0054202	58	2	9.2013449	10.7986551	58
3	9.1967186	9.9945597	0.8032814	0.0054403	57	3	9.2021588	10.7978412	57
4	9.1975110	9.9945396	0.8024860	0.0054604	56	4	9.2029714	10.7970286	56
5	9.1983019	9.9945194	0.8016381	0.0054806	55	5	9.2037825	10.7962175	55
6	9.1990913	9.9944992	0.8009087	0.0055008	54	6	9.2045922	10.7954078	54
7	9.1998793	9.9944789	0.8001207	0.0055210	53	7	9.2054004	10.7945996	53
8	9.2006658	9.9944587	0.7993342	0.0055413	52	8	9.2062072	10.7937928	52
9	9.2014509	9.9944383	0.7985491	0.0055617	51	9	9.2070126	10.7929874	51
10	9.2022345	9.9944180	0.7977655	0.0055820	50	10	9.2078165	10.7921835	50
11	9.2030167	9.9943975	0.7969833	0.0056025	49	11	9.2086191	10.7913809	49
12	9.2037974	9.9943771	0.7962026	0.0056229	48	12	9.2094203	10.7905797	48
13	9.2045766	9.9943566	0.7954234	0.0056434	47	13	9.2102200	10.7897800	47
14	9.2053545	9.9943361	0.7946455	0.0056434	46	14	9.2110184	10.7889816	46
15	9.2061309	9.9943156	0.7938691	0.0056844	45	15	9.2118153	10.7881847	45
16	9.2069059	9.9942950	0.7930941	0.0057050	44	16	9.2126109	10.7873891	44
17	9.2076795	9.9942743	0.7923205	0.0057227	43	17	9.2134051	10.7865949	43
18	9.2084516	9.9942537	0.7915484	0.0057463	42	18	9.2141980	10.7858020	42
19	9.2092224	9.9942330	0.7907776	0.0057670	41	19	9.2149894	10.7850106	41
20	9.2099917	9.9942122	0.7900083	0.0057878	40	20	9.2157795	10.7842205	40
21	9.2107567	9.9941914	0.7892403	0.0058086	39	21	9.2165683	10.7834317	39
22	9.2115263	9.9941706	0.7884737	0.0058294	38	22	9.2173556	10.7826444	38
23	9.2122914	9.9941498	0.7877086	0.0058502	37	23	9.2181417	10.7818583	37
24	9.2130552	9.9942289	0.7869448	0.0058711	36	24	9.2189264	10.7810736	36
25	9.2138176	9.9941079	0.7861824	0.0058921	35	25	9.2197097	10.7802903	35
26	9.2145787	9.9940870	0.7854213	0.0059130	34	26	9.2204917	10.7795083	34
27	9.2153384	9.9940659	0.7846616	0.0059341	33	27	9.2212724	10.7787276	33
28	9.2160967	9.9940449	0.7839033	0.0059551	32	28	9.2220518	10.7779482	32
29	9.2168536	9.9940238	0.7831464	0.0059762	31	29	9.2228298	10.7771702	31
30	9.2176092	9.9940027	0.7823908	0.0059973	30	30	9.2236065	10.7763935	30
31	9.2183635	9.9939815	0.7816365	0.0060185	29	31	9.2243819	10.7756181	29
32	9.2191164	9.9939603	0.7808836	0.0060397	28	32	9.2251561	10.7748439	28
33	9.2198680	9.9939391	0.7801320	0.0060609	27	33	9.2259289	10.7740711	27
34	9.2206182	9.9939178	0.7793818	0.0060822	26	34	9.2267004	10.7732996	26
35	9.2213671	9.9938965	0.7786329	0.0061035	25	35	9.2274706	10.7725294	25
36	9.2221147	9.9938712	0.7778853	0.0061248	24	36	9.2282395	10.7717605	24
37	9.2228609	9.9938538	0.7771391	0.0061462	23	37	9.2290071	10.7709929	23
38	9.2236059	9.9938324	0.7763941	0.0061676	22	38	9.2297735	10.7702265	22
39	9.2243495	9.9938109	0.7756505	0.0061891	21	39	9.2305386	10.7694614	21
40	9.2250918	9.9937894	0.7749082	0.0062106	20	40	9.2313024	10.7686976	20
41	9.2258328	9.9937679	0.7741672	0.0062321	19	41	9.2320650	10.7679350	19
42	9.2265725	9.9937463	0.7734275	0.0062537	18	42	9.2328262	10.7671738	18
43	9.2273110	9.9937247	0.7726890	0.0062753	17	43	9.2335863	10.7664137	17
44	9.2280481	9.9937030	0.7719519	0.0062970	16	44	9.2343451	10.7656549	16
45	9.2287839	9.9936813	0.7712161	0.0063187	15	45	9.2351026	10.7648974	15
46	9.2295185	9.9936596	0.7704815	0.0063404	14	46	9.2358589	10.7641411	14
47	9.2302518	9.9936378	0.7697482	0.0063622	13	47	9.2366139	10.7633861	13
48	9.2309838	9.9936160	0.7690162	0.0063840	12	48	9.2373678	10.7626322	12
49	9.2317145	9.9935942	0.7682855	0.0064058	11	49	9.2381203	10.7618797	11
50	9.2324440	9.9935723	0.7675560	0.0064277	10	50	9.2388717	10.7611283	10
51	9.2331722	9.9935504	0.7668278	0.0064496	9	51	9.2396218	10.7603782	9
52	9.2338992	9.9935285	0.7661008	0.0064715	8	52	9.2403708	10.7596292	8
53	9.2346249	9.9935065	0.7653751	0.0064935	7	53	9.2411185	10.7588815	7
54	9.2353494	9.9934844	0.7646506	0.0065156	6	54	9.2418650	10.7581350	6
55	9.2360726	9.9934624	0.7639274	0.0065376	5	55	9.2426103	10.7573897	5
56	9.2367946	9.9934403	0.7632054	0.0065597	4	56	9.2433543	10.7666457	4
57	9.2375153	9.9934181	0.7624847	0.0065819	3	57	9.2440972	10.7559028	3
58	9.2382349	9.9933959	0.7617651	0.0066041	2	58	9.2448389	10.7551611	2
59	9.2389532	9.9933737	0.7610468	0.0066263	1	59	9.2455794	10.7544206	1
60	9.2396702	9.9933515	0.7603298	0.0066485	0	60	9.2463188	10.7536812	0
			Co. Arith.	Sign.				Tangent.	

Degrees 80.

Degrees 10.

M.	Sign.	Co. Arith.			
0	9.2396702	9.9933515	0.7603298	0.0066485	60
1	9.2403861	9.9933292	0.7596139	0.0066708	59
2	9.2411007	9.9933068	0.7588993	0.0066932	58
3	9.2418141	9.9932845	0.7581859	0.0067155	57
4	9.2425264	9.9932621	0.7574736	0.0067379	56
5	9.2432374	9.9932395	0.7567626	0.0067604	55
6	9.2439472	9.9932171	0.7560528	0.0067829	54
7	9.2446558	9.9931946	0.7553442	0.0068054	53
8	9.2453632	9.9931720	0.7546368	0.0068280	52
9	9.2460695	9.9931494	0.7539305	0.0068506	51
10	9.2467746	9.9931268	0.7532254	0.0068732	50
11	9.2474784	9.9931041	0.7525216	0.0068959	49
12	9.2481811	9.9930814	0.7518189	0.0069186	48
13	9.2488827	9.9930587	0.7511173	0.0069413	47
14	9.2495830	9.9930359	0.7504170	0.0069641	46
15	9.2502822	9.9930131	0.7497178	0.0069869	45
16	9.2509803	9.9929902	0.7490197	0.0070098	44
17	9.2516772	9.9929673	0.7483228	0.0070327	43
18	9.2523729	9.9929444	0.7476271	0.0070556	42
19	9.2530675	9.9929214	0.7469325	0.0070786	41
20	9.2537609	9.9928984	0.7462391	0.0071016	40
21	9.2544532	9.9928753	0.7455468	0.0071247	39
22	9.2551444	9.9928522	0.7448556	0.0071478	38
23	9.2558344	9.9928291	0.7441656	0.0071709	37
24	9.2565233	9.9928059	0.7434767	0.0071941	36
25	9.2572110	9.9927827	0.7427890	0.0072173	35
26	9.2578977	9.9927595	0.7421023	0.0072405	34
27	9.2585832	9.9927362	0.7414168	0.0072638	33
28	9.2592676	9.9927129	0.7407324	0.0072871	32
29	9.2599509	9.9926895	0.7400491	0.0073105	31
30	9.2606330	9.9926661	0.7393670	0.0073339	30
31	9.2613141	9.9926427	0.7386859	0.0073573	29
32	9.2619941	9.9926192	0.7380059	0.0073808	28
33	9.2626729	9.9925957	0.7373271	0.0074043	27
34	9.2633507	9.9925722	0.7366493	0.0074278	26
35	9.2640274	9.9925486	0.7359726	0.0074514	25
36	9.2647030	9.9925250	0.7352970	0.0074750	24
37	9.2653775	9.9925013	0.7346225	0.0074987	23
38	9.2660509	9.9924776	0.7339491	0.0075224	22
39	9.2667232	9.9924539	0.7332768	0.0075461	21
40	9.2673945	9.9924301	0.7326055	0.0075699	20
41	9.2680647	9.9924063	0.7319353	0.0075937	19
42	9.2687338	9.9923824	0.7312662	0.0076176	18
43	9.2694019	9.9923585	0.7305981	0.0076415	17
44	9.2700689	9.9923346	0.7299311	0.0076654	16
45	9.2707348	9.9923106	0.7292652	0.0076894	15
46	9.2713997	9.9922866	0.7286003	0.0077134	14
47	9.2720635	9.9922626	0.7279365	0.0077374	13
48	9.2727263	9.9922385	0.7272737	0.0077615	12
49	9.2733880	9.9922144	0.7266120	0.0077856	11
50	9.2740487	9.9921902	0.7259513	0.0078098	10
51	9.2747083	9.9921660	0.7252917	0.0078340	9
52	9.2753669	9.9921418	0.7246331	0.0078582	8
53	9.2760245	9.9921175	0.7239755	0.0078825	7
54	9.2766811	9.9920932	0.7233189	0.0079068	6
55	9.2773365	9.9922689	0.7226634	0.0079311	5
56	9.2779911	9.9920445	0.7220089	0.0079555	4
57	9.2786445	9.9920201	0.7213555	0.0079799	3
58	9.2792970	9.9919956	0.7207030	0.0070044	2
59	9.2799484	9.9919711	0.7200516	0.0070289	1
60	9.2805988	9.9919466	0.7194012	0.0070534	0
			Co. Arith.	Sign.	

	Tangent.		
0	9.2463188	10.7536812	60
1	9.2470569	10.7529431	59
2	9.2477939	10.7522061	58
3	9.2485297	10.7514703	57
4	9.2492643	10.7507357	56
5	9.2499978	10.7500022	55
6	9.2507301	10.7492699	54
7	9.2514612	10.7485388	53
8	9.2521912	10.7478088	52
9	9.2529200	10.7470800	51
10	9.2539477	10.7463523	50
11	9.2543743	10.7456257	49
12	9.2550997	10.7449003	48
13	9.2558240	10.7441760	47
14	9.2565472	10.7434528	46
15	9.2562592	10.7427308	45
16	9.2579901	10.7420099	44
17	9.2587099	10.7412901	43
18	9.2594285	10.7405715	42
19	9.2601461	10.7398539	41
20	9.2608625	10.7391375	40
21	9.2615779	10.7384221	39
22	9.2622921	10.7377079	38
23	9.2630053	10.7369947	37
24	9.2637173	10.7362827	36
25	9.2644283	10.7355717	35
26	9.2652382	10.7348618	34
27	9.2658470	10.7341530	33
28	9.2665547	10.7334453	32
29	9.2672613	10.7327387	31
30	9.2679669	10.7320331	30
31	9.2686714	10.7313286	29
32	9.2693749	10.7306251	28
33	9.2700772	10.7299228	27
34	9.2707786	10.7292214	26
35	9.2714788	10.7285212	25
36	9.2721780	10.7278220	24
37	9.2728762	10.7271238	23
38	9.2735733	10.7264267	22
39	9.2742694	10.7257306	21
40	9.2749644	10.7250356	20
41	9.2756584	10.7243416	19
42	9.2763514	10.7236486	18
43	9.2770434	10.7229566	17
44	9.2777353	10.7222657	16
45	9.2784212	10.7215758	15
46	9.2791131	10.7208869	14
47	9.2798009	10.7201991	13
48	9.2804878	10.7195122	12
49	9.2811736	10.7188264	11
50	9.2818585	10.7181415	10
51	9.2825423	10.7174577	9
52	9.2832251	10.7167749	8
53	9.2839070	10.7160930	7
54	9.2845878	10.7154122	6
55	9.2852677	10.7147323	5
56	9.2859466	10.7140534	4
57	9.2866245	10.7133755	3
58	9.2873014	10.7126986	2
59	9.2879773	10.7120227	1
60	9.2886523	10.7113477	0
		Tangent.	

Degrees 79.

M.	Sign.	Co. Arith.					Tangent.		
0	9.2805988	9.9919456	0.7194012	0.0080534	60	0	9.2886523	10.7113477	60
1	9.2812483	9.9919220	0.7187517	0.0080780	59	1	9.2893263	10.7106737	59
2	9.2818967	9.9918974	0.7181033	0.0081026	58	2	9.2899993	10.7100007	58
3	9.2825441	9.9918727	0.7174559	0.0081273	57	3	9.2906713	10.7093287	57
4	9.2831905	9.9918480	0.7168095	0.0081520	56	4	9.2913424	10.7086576	56
5	9.2838359	9.9918233	0.7161641	0.0081767	55	5	9.2920126	10.7079874	55
6	9.2844803	9.9917986	0.7155197	0.0082014	54	6	9.2926817	10.7073183	54
7	9.2851237	9.9917737	0.7148763	0.0082263	53	7	9.2933500	10.7066500	53
8	9.2857661	9.9917489	0.7142339	0.0082511	52	8	9.2940172	10.7059828	52
9	9.2864075	9.9917240	0.7135924	0.0082760	51	9	9.2946836	10.7053164	51
10	9.2870480	9.9916991	0.7129520	0.0083009	50	10	9.2953489	10.7046511	50
11	9.2876875	9.9916741	0.7123125	0.0083259	49	11	9.2960134	10.7039866	49
12	9.2883260	9.9916492	0.7116740	0.0083508	48	12	9.2966769	10.7033231	48
13	9.2889636	9.9916241	0.7110364	0.0083759	47	13	9.2973395	10.7026605	47
14	9.2896001	9.9915990	0.7103999	0.0084010	46	14	9.2980012	10.7019989	46
15	9.2902357	9.9915739	0.7097643	0.0084261	45	15	9.2986618	10.7013382	45
16	9.2908704	9.9915488	0.7091296	0.0084512	44	16	9.2993216	10.7006784	44
17	9.2915040	9.9915236	0.7084960	0.0084764	43	17	9.2999804	10.7000196	43
18	9.2921367	9.9914984	0.7078633	0.0085016	42	18	9.3006383	10.6993617	42
19	9.2927685	9.9914731	0.7072315	0.0085269	41	19	9.3012954	10.6987046	41
20	9.2933993	9.9914478	0.7066007	0.0085522	40	20	9.3019514	10.6980486	40
21	9.2940291	9.9914225	0.7059709	0.0085775	39	21	9.3026066	10.6973934	39
22	9.2946580	9.9913971	0.7053420	0.0086029	38	22	9.3032609	10.6967391	38
23	9.2952859	9.9913717	0.7047141	0.0086283	37	23	9.3039143	10.6960857	37
24	9.2959129	9.9913462	0.7040871	0.0086538	36	24	9.3045667	10.6954333	36
25	9.2965390	9.9913207	0.7034610	0.0086793	35	25	9.3052183	10.6947817	35
26	9.2971641	9.9912952	0.7028359	0.0087048	34	25	9.3058689	10.6941311	34
27	9.2977883	9.9912696	0.7022117	0.0087304	33	27	9.3065187	10.6934813	33
28	9.2984116	9.9912440	0.7015884	0.0087560	32	28	9.3071675	10.6928425	32
29	9.2990339	9.9912184	0.7009661	0.0087816	31	29	9.3078155	10.6921845	31
30	9.2996553	9.9911927	0.7003447	0.0088073	30	30	9.3084626	10.6915374	30
31	9.3002758	9.9911670	0.6997242	0.0088330	29	31	9.3091088	10.6908912	29
32	9.3008953	9.9911412	0.6991047	0.0088588	28	32	9.3097541	10.6902459	28
33	9.3015140	9.9911154	0.6984860	0.0088846	27	33	9.3103985	10.6896015	27
34	9.3021317	9.9910896	0.6978683	0.0089104	26	34	9.3110421	10.6889479	26
35	9.3027485	9.9910637	0.6972515	0.0089363	25	35	9.3116848	10.6883152	25
36	9.3033644	9.9910378	0.6966356	0.0089622	24	36	9.3123266	10.6876734	24
37	9.3039794	9.9910119	0.6960206	0.0089881	23	37	9.3129675	10.6870325	23
38	9.3045934	9.9909859	0.6954066	0.0090141	22	38	9.3136076	10.6863924	22
39	9.3052066	9.9909598	0.6947934	0.0090402	21	39	9.3142468	10.6857532	21
40	9.3058189	9.9909338	0.6941811	0.0090662	20	40	9.3148851	10.6851149	20
41	9.3064303	9.9909077	0.6935697	0.0090923	19	41	9.3155226	10.6844774	19
42	9.3070407	9.9908815	0.6929593	0.0091185	18	42	9.3161592	10.6838408	18
43	9.3076503	9.9908553	0.6923497	0.0091447	17	43	9.3167950	10.6832050	17
44	9.3082590	9.9908291	0.6917410	0.0091709	16	44	9.3174299	10.6825701	16
45	9.3088668	9.9908029	0.6911332	0.0091971	15	45	9.3180640	10.6819360	15
46	9.3094737	9.9907766	0.6905263	0.0092234	14	46	9.3186971	10.6813028	14
47	9.3100798	9.9907502	0.6899202	0.0092498	13	47	9.3193295	10.6806705	13
48	9.3106849	9.9907239	0.6893151	0.0092761	12	48	9.3199611	10.6800389	12
49	9.3112892	9.9906974	0.6887108	0.0093026	11	49	9.3205918	10.6794082	11
50	9.3118926	9.9906710	0.6881074	0.0093290	10	50	9.3212216	10.6787784	10
51	9.3124951	9.9906445	0.6875049	0.0093555	9	51	9.3218506	10.6781494	9
52	9.3130968	9.9906180	0.6869032	0.0093820	8	52	9.3224788	10.6775212	8
53	9.3136976	9.9905914	0.6863024	0.0094086	7	53	9.3231061	10.6768939	7
54	9.3142975	9.9905648	0.6857025	0.0094352	6	54	9.3237327	10.6762673	6
55	9.3148965	9.9905382	0.6851035	0.0094618	5	55	9.3243584	10.6756416	5
56	9.3154949	9.9905115	0.6845053	0.0094885	4	56	9.3249832	10.6750168	4
57	9.3160921	9.9904848	0.6839079	0.0095152	3	57	9.3256073	10.6743927	3
58	9.3166885	9.9904580	0.6833115	0.0095420	2	58	9.3262305	10.6737695	2
59	9.3172841	9.9904312	0.6827159	0.0095688	1	59	9.3268529	10.6731471	1
60	9.3178789	9.9904044	0.6821211	0.0095956	0	60	9.3274745	10.6725255	0
			Co. Arith.	Sign.				Tangent.	

M.	Sign.	Co. Arith.			
0	9.3178789	9.9904044	0.6821211	0.0095956	60
1	9.3184728	9.9903775	0.6815272	0.0096225	59
2	9.3190659	9.9903506	0.6809341	0.0096494	58
3	9.3196581	9.9903237	0.6803419	0.0096763	57
4	9.3202495	9.9902967	0.6797505	0.0097033	56
5	9.3204400	9.9902697	0.6791600	0.0097303	55
6	9.3214297	9.9902426	0.6785703	0.0097574	54
7	9.3220186	9.9902155	0.6779814	0.0097845	53
8	9.3226066	9.9901883	0.6773934	0.0098117	52
9	9.3231938	9.9901612	0.6768062	0.0098328	51
10	9.3237802	9.9901330	0.6762198	0.0098661	50
11	9.3243657	9.9901067	0.6756343	0.0098933	49
12	9.3249505	9.9900754	0.6750495	0.0099205	48
13	9.3255344	9.9900521	0.6744656	0.0099479	47
14	9.3261174	9.9900247	0.6738826	0.0099753	46
15	9.3266997	9.9899973	0.6733003	0.0100027	45
16	9.3272811	9.9899698	0.6727189	0.0100302	44
17	9.3278617	9.9899424	0.6721383	0.0100577	43
18	9.3284416	9.9899148	0.6715584	0.0100852	42
19	9.3290206	9.9898873	0.6709794	0.0101127	41
20	9.3295988	9.9898597	0.6704012	0.0101403	40
21	9.3301761	9.9898320	0.6698239	0.0101680	39
22	9.3307527	9.9898043	0.6692473	0.0101957	38
23	9.3313285	9.9897766	0.6686715	0.0102234	37
24	9.3319035	9.9897489	0.6680965	0.0102511	36
25	9.3324777	9.9897211	0.6675223	0.0102789	35
26	9.3330511	9.9896932	0.6669489	0.0103068	34
27	9.3336237	9.9896654	0.6663763	0.0103346	33
28	9.3341955	9.9896374	0.6658045	0.01036.6	32
29	9.3347665	9.9896095	0.6652335	0.0103905	31
30	9.3353368	9.9895815	0.6646632	0.0104185	30
31	9.3359062	9.9895535	0.6640938	0.0104465	29
32	9.3364749	9.9895254	0.6635251	0.0104746	28
33	9.3370428	9.9894973	0.6629572	0.0105027	27
34	9.3376099	9.9894692	0.6623901	0.0105308	26
35	9.3381762	9.9894410	0.6618274	0.0105590	25
36	9.3387418	9.9894128	0.6612582	0.0105872	24
37	9.3393065	9.9893845	0.6606935	0.0105155	23
38	9.3398706	9.9893562	0.6601294	0.0106438	22
39	9.3404338	9.9893279	0.6595662	0.0106721	21
40	9.3409963	9.9892995	0.6590037	0.0107005	20
41	9.3415580	9.9892711	0.6584420	0.0107289	19
42	9.3421190	9.9892427	0.6578810	0.0107573	18
43	9.3426792	9.9892142	0.6573208	0.0107858	17
44	9.3432386	9.9891856	0.6567614	0.0108144	16
45	9.3437973	9.9891571	0.6562027	0.0108429	15
46	9.3443552	9.9891285	0.6556448	0.0108716	14
47	9.3449124	9.9890998	0.6550876	0.0109002	13
48	9.3454688	9.9890711	0.6545312	0.0109289	12
49	9.3460245	9.9890424	0.6539755	0.0109576	11
50	9.3465794	9.9890137	0.6534206	0.0109863	10
51	9.3471336	9.9889849	0.6528664	0.0110151	9
52	9.3476870	9.9889560	0.6523130	0.0110440	8
53	9.3482397	9.9889271	0.6517603	0.0110729	7
54	9.3487917	9.9888982	0.6512083	0.0111018	6
55	9.3493429	9.9888693	0.6506571	0.0111307	5
56	9.3498934	9.9888403	0.6501066	0.0111597	4
57	9.3504432	9.9888113	0.6495568	0.0111887	3
58	9.3509922	9.9887822	0.6490078	0.0112198	2
59	9.3515405	9.9887531	0.6484595	0.0112469	1
60	9.3520880	9.9887239	0.6479520	0.0112761	0
			Co. Arith.	Sign.	

	Tangent.		
0	9.3274745	10.6725255	60
1	9.3280953	10.6719047	59
2	9.3287153	10.6712847	58
3	9.3293345	10.6706655	57
4	9.3299528	10.6700472	56
5	9.3305704	10.6694296	55
6	9.3311872	10.6688128	54
7	9.3318031	10.6681969	53
8	9.3324183	10.6675817	52
9	9.3330327	10.6669673	51
10	9.3336463	10.6663537	50
11	9.3342591	10.6657409	49
12	9.3348711	10.6651289	48
13	9.3354823	10.6646177	47
14	9.3360927	10.6639073	46
15	9.3367024	10.6622975	45
16	9.3373117	10.6626887	44
17	9.3379194	10.6620806	43
18	9.3381267	10.6614733	42
19	9.3391333	10.6608667	41
20	9.3397391	10.6602609	40
21	9.3403441	10.6596559	39
22	9.3409484	10.6590516	38
23	9.3415519	10.6584481	37
24	9.3421546	10.6578454	36
25	9.3427566	10.6572434	35
26	9.3433578	10.6566422	34
27	9.3439583	10.6560417	33
28	9.3445580	10.6554420	32
29	9.3451570	10.6548430	31
30	9.3457552	10.6542448	30
31	9.3463527	10.6536473	29
32	9.3469494	10.6530506	28
33	9.3475454	10.6524546	27
34	9.3481407	10.6518593	26
35	9.3487352	10.6512648	25
36	9.3493290	10.6506710	24
37	9.3499220	10.6500780	23
38	9.3505143	10.6494857	22
39	9.3511059	10.6488941	21
40	9.3516968	10.6482032	20
41	9.3522869	10.6477131	19
42	9.3528763	10.6471237	18
43	9.3534650	10.6465350	17
44	9.3540530	10.6459470	16
45	9.3546402	10.6453598	15
46	9.3552267	10.6447733	14
47	9.3558126	10.6441874	13
48	9.3563977	10.6436023	12
49	9.3569821	10.6430179	11
50	9.3575658	10.6424342	10
51	9.3581487	10.6418513	9
52	9.3587310	10.6412690	8
53	9.3593126	10.6406874	7
54	9.3598935	10.6401065	6
55	9.3604736	10.6395264	5
56	9.3610531	10.6389469	4
57	9.3616319	10.6383681	3
58	9.3622100	10.6377900	2
59	9.3627874	10.6372126	1
60	9.3633641	10.6366359	0
		Tangent.	

D.	Sign.	Co. Arith.					Tangent.		
0	9.3520880	9.9887239	0.6479120	0.0112761	60	0	9.3633641	10.6366359	60
1	9.3526349	9.9886947	0.6473651	0.0113053	59	1	9.3639401	10.6360599	59
2	9.3531810	9.9886655	0.6468190	0.0113345	58	2	9.3645155	10.6354845	58
3	9.3537264	9.9886363	0.6462736	0.0113637	57	3	9.3650901	10.6349099	57
4	9.3542710	9.9886070	0.6457290	0.0113930	56	4	9.3656641	10.6343359	56
5	9.3548150	9.9885776	0.6451856	0.0114224	55	5	9.3662374	10.6337626	55
6	9.3553582	9.9885482	0.6446418	0.0114518	54	6	9.3668100	10.6331900	54
7	9.3559007	9.9885188	0.6440993	0.0114812	53	7	9.3673819	10.6326181	53
8	9.3564426	9.9884894	0.6435574	0.0115106	52	8	9.3679532	10.6320468	52
9	9.3569836	9.9884599	0.6430164	0.0115401	51	9	9.3685238	10.6314762	51
10	9.3575240	9.9884303	0.6424760	0.0115697	50	10	9.3690937	10.6309063	50
11	9.3580637	9.9884008	0.6419363	0.0115992	49	11	9.3605629	10.6303371	49
12	9.3586027	9.9883712	0.6413973	0.0116288	48	12	9.3702315	10.6297685	48
13	9.3591409	9.9883415	0.6408591	0.0116585	47	13	9.3707994	10.6292006	47
14	9.3596785	9.9883118	0.6403215	0.0116882	46	14	9.3713667	10.6286333	46
15	9.3602154	9.9882821	0.6397845	0.0117179	45	15	9.3719333	10.6280667	45
16	9.3607515	9.9882523	0.6392485	0.0117477	44	16	9.3724992	10.6275008	44
17	9.3612870	9.9882225	0.6387130	0.0117775	43	17	9.3730645	10.6269355	43
18	9.3618217	9.9881927	0.6381783	0.0118073	42	18	9.3736291	10.6263709	42
19	9.3623558	9.9881628	0.6376442	0.0118372	41	19	9.3741930	10.6258070	41
20	9.3628892	9.9881329	0.6371108	0.0118671	40	20	5.3747563	10.6252437	40
21	9.3634219	9.9881029	0.6365781	0.0118971	39	21	9.3753190	10.6246810	39
22	9.3639539	9.9880729	0.6360461	0.0119271	38	22	9.3758810	10.6241190	38
23	9.3644852	9.9880429	0.6355148	0.0119571	37	23	9.3764423	10.6235577	37
24	9.3650158	9.9880128	0.6349842	0.0119872	36	24	9.3770030	10.6229970	36
25	9.3655458	9.9879827	0.6344542	0.0120173	35	25	9.3775631	10.6224369	35
26	9.3660750	9.9879525	0.6339250	0.0120475	34	26	9.3781225	10.6218775	34
27	9.3666036	9.9879223	0.6333964	0.0120777	33	27	9.3786813	10.6213187	33
28	9.3671315	9.9878921	0.6328685	0.0121079	32	28	9.3792394	10.6207606	32
29	9.3676587	9.9878618	0.6323413	0.0121382	31	29	9.3797969	10.5202031	31
30	9.3681853	9.9878315	0.6318147	0.0121685	30	30	9.3803537	10.6196463	30
31	9.3687111	9.9878012	0.6312889	0.0121988	29	31	9.3809100	10.6190900	29
32	9.3692363	9.9877708	0.6307637	0.0122292	28	32	9.3814655	10.6185345	28
33	9.3697608	9.9877404	0.6302392	0.0122596	27	33	9.3820205	10.6179795	27
34	9.3702847	9.9877099	0.6297153	0.0122901	26	34	9.3825748	10.6174252	26
35	9.3708079	9.9876794	0.6291921	0.0123206	25	35	9.3831285	10.6168715	25
36	9.3713304	9.9876488	0.6286696	0.0123512	24	36	9.3836816	10.6163184	24
37	9.3718523	9.9876183	0.6281477	0.0123817	23	37	9.3842340	10.6157660	23
38	9.3723735	9.9875870	0.6276265	0.0124124	22	38	9.3847858	10.6152142	22
39	9.3728940	9.9875570	0.6271060	0.0124430	21	39	9.3853370	10.6146630	21
40	9.3734139	9.9875263	0.6265861	0.0124737	20	40	9.3858876	10.6141124	20
41	9.3739331	9.9874955	0.6260669	0.0125045	19	41	9.3864376	10.6135624	19
42	9.3744517	9.9874648	0.6255483	0.0125352	18	42	9.3869869	10.6130131	18
43	9.3749696	9.9874339	0.6250304	0.0125661	17	43	9.3875356	10.6124644	17
44	9.3754868	9.9874031	0.6245132	0.0125969	16	44	9.3880837	10.6119163	16
45	9.3760034	9.9873722	06239966	0.0126278	15	45	9.3886312	10.6113688	15
46	9.3765194	9.9873413	6.6234806	0.0126587	14	46	9.3891781	10.6108219	14
47	9.3770347	9.9873103	0.6229653	0.0126897	13	47	9.3897244	10.6102756	13
48	9.3775493	9.9872793	0.6224507	0.0127207	12	48	9.3902700	10.6097300	12
49	9.3780633	9.9872482	0.6219367	0.0127518	11	49	9.3908151	10.6091849	11
50	9.3785767	9.9872171	0.6214233	0.0127829	10	50	9.3913595	10.6086405	10
51	9.3790894	9.9871860	0.6209106	0.0128140	9	51	9.3919034	10.6080965	9
52	9.3796015	9.9871545	0.6203985	0.0128451	8	52	9.3924466	10.6075534	8
53	9.3801129	9.9871236	0.6198871	0.0128764	7	53	9.3929893	10.6070107	7
54	9.3806237	9.9870924	0.6193763	0.0129076	6	54	9.3935313	10.6064687	6
55	9.3811339	9.9870611	0.6188661	0.0129389	5	55	9.3940727	10.6059273	5
56	9.3816424	9.9870298	0.6183566	0.0129702	4	56	9.3946136	10.6053864	4
57	9.3821523	9.9869984	0.6178477	0.0130016	3	57	9.3951538	10.6048462	3
58	9.3826605	9.9869670	0.6173395	0.0130330	2	58	9.3956935	10.6043065	2
59	9.3831682	9.9869356	0.6168318	0.0130644	1	59	9.3962326	10.6037674	1
60	9.3836752	9.9869041	0.6163248	0.0130959	0	60	9.3967711	10.6032289	0
			Co. Arith.	Sign.				Tangent.	

Degrees 14.

D.	Sign.	Co. Arith.			
0	9.3839752	9.9869041	0.6163248	0.0130959	60
1	9.3841815	9.9868725	0.6158185	0.0131274	59
2	9.3846873	9.9868410	0.6153127	0.0131590	58
3	9.3851924	9.9868094	0.6148076	0.0131902	57
4	9.3856969	9.9867778	0.6143031	0.0132222	56
5	9.3862008	9.9867461	0.6137992	0.0132539	55
6	9.3867040	9.9868144	0.6132960	0.0132856	54
7	9.3872067	9.9866827	0.6127933	0.0133173	53
8	9.3877087	9.9866509	0.6122913	0.0133491	52
9	9.3882101	9.9866191	0.6117899	0.0133809	51
10	9.3887109	9.9865872	0.6112891	0.0134128	50
11	9.3892111	9.9865553	0.6107889	0.0134447	49
12	9.3897106	9.9865233	0.6102894	0.0134767	48
13	9.3902099	9.9864913	0.6097904	0.0135087	47
14	9.3907079	9.9864593	0.6092921	0.0135417	46
15	9.3912057	9.9864272	0.6087943	0.0135727	45
16	9.3917028	9.9863951	0.6082972	0.0136048	44
17	9.3921993	9.9863630	0.6078007	0.0136370	43
18	9.3926952	9.9863308	0.6073048	0.0136692	42
19	9.3931905	9.9862986	0.6068095	0.0137014	41
20	9.3936852	9.9862663	0.6063148	0.0137337	40
21	9.3941794	9.9862340	0.6058206	0.0137660	39
22	9.3946729	9.9862017	0.6053271	0.0137983	38
23	9.3951658	9.9861693	0.6048342	0.0138307	37
24	9.3956581	9.9861369	0.6043419	0.0138631	36
25	9.3951499	9.9861045	0.6038501	0.0138955	35
26	9.3966410	9.9860720	0.6033590	0.0139280	34
27	9.3971315	9.9860394	0.6028685	0.0139606	33
28	9.3976215	9.9860069	0.6023785	0.0139931	32
29	9.3981109	9.9859742	0.6018891	0.0140258	31
30	9.3988996	9.9859416	0.6014004	0.0140584	30
31	9.3990878	9.9859089	0.6009122	0.0140911	29
32	9.3995754	9.9858762	0.6004246	0.0141238	28
33	9.4000625	9.9858434	0.5999375	0.0141566	27
34	9.4005489	9.9858106	0.5994511	0.0141894	26
35	9.4010348	9.9857777	0.5989652	0.0142223	25
36	9.4015201	9.9857449	0.5984799	0.0142551	24
37	9.4020048	9.9857119	0.5979952	0.0142881	23
38	9.4024889	9.9856790	0.5975111	0.0143210	22
39	9.4029734	9.9856460	0.5970276	0.0143540	21
40	9.4034554	9.9856129	0.5965446	0.0143871	20
41	9.4039378	9.9855798	0.5960622	0.0144202	19
42	9.4044196	9.9855467	0.5955804	0.0144533	18
43	9.4049009	9.9855135	0.5950991	0.0144865	17
44	9.4053816	9.9854803	0.5946184	0.0145197	16
45	9.4058617	9.9854471	0.5941383	0.0145529	15
46	9.4063413	9.9854138	6.5936587	0.0145862	14
47	9.4068203	9.9853805	0.5931797	0.0146195	13
48	9.4072987	9.9853471	0.5927013	0.0146529	12
49	9.4077766	9.9853138	0.5922234	0.0146852	11
50	9.4082539	9.9852803	0.5917461	0.0147197	10
51	9.4087306	9.9852468	0.5912694	0.0147532	9
52	9.4092068	9.9852133	0.5907932	0.0147867	8
53	9.4096824	9.9851798	0.5903176	0.0148202	7
54	9.4101575	9.9851462	0.5898425	0.0148538	6
55	9.4106320	9.9851125	0.5893680	0.0148875	5
56	9.4111059	9.9850789	0.5888941	0.0149211	4
57	9.4115793	9.9850452	0.5884207	0.0149548	3
58	9.4120522	9.9850114	0.5879478	0.0149886	2
59	9.4125245	9.9849776	0.5874755	0.0150224	1
60	9.4129962	9.9849438	0.5870038	0.0150562	0
			Co. Arith.	Sign	

	Tangent.		
0	9.3967711	10.6032289	60
1	9.3973089	10.6026511	59
2	9.3978463	10.6021537	58
3	9.3983330	10.6016170	57
4	9.3989191	10.6010809	56
5	9.3994547	10.6005453	55
6	9.3999896	10.6000104	54
7	9.4005240	10.5994760	53
8	9.4010578	10.5989422	52
9	9.4015910	10.5984090	51
10	9.4021237	10.5978763	50
11	9.4026558	10.5973442	49
12	9.4031873	10.5968127	48
13	9.4037182	10.5962818	47
14	9.4042486	10.5957514	46
15	9.4047784	10.5952216	45
16	9.4053076	10.5946924	44
17	9.4058363	10.5941637	43
18	9.4063644	10.5936356	42
19	9.4068919	10.5931081	41
20	5.4 74189	10.5925810	40
21	9.4079453	10.5920547	39
22	9.4083712	10.5915288	38
23	9.4089965	10.5910035	37
24	9.4095212	10.5904788	36
25	9.4100454	10.5899546	35
26	9.4105690	10.5894310	34
27	9.4110921	10.5889079	33
28	9.4116146	10.5883854	32
29	9.4121366	10.5878634	31
30	9.4126581	10.5873419	30
31	9.4131789	10.5868211	29
32	9.4136993	10.5863007	28
33	9.4142191	10.5857809	27
34	9.4147383	10.5852617	26
35	9.4152570	10.5847430	25
36	9.4157752	10.5842248	24
37	9.4162928	10.5837072	23
38	9.4168099	10.5831901	22
39	9.4173265	10.5826735	21
40	9.4178425	10.5821575	20
41	9.4183580	10.5816420	19
42	9.4188729	10.5811271	18
43	9.4193874	10.5806126	17
44	9.4199013	10.5800987	16
45	9.4204146	10.5795854	15
46	9.4209274	10.5790725	14
47	9.4214398	10.5785602	13
48	9.4219515	10.5780485	12
49	9.4224628	10.5775372	11
50	9.4229735	10.5770265	10
51	9.4234833	10.5765162	9
52	9.4239935	10.5760065	8
53	9.4245026	10.5754974	7
54	9.4250113	10.5749887	6
55	9.4255194	10.5744806	5
56	9.4260271	10.5739729	4
57	9.4265342	10.5734658	3
58	9.4270408	10.5729592	2
59	9.4275469	10.5724531	1
60	9.4280525	10.5719475	0
		Tangent.	

Degrees 75.

D.	Sign.	Co. Arith.					Tangent.		
0	9.4129962	9.9849438	0.5870038	0.0150562	60	0	9.4280525	10.5719475	60
1	9.4134674	9.9849099	0.5865326	0.0150901	59	1	9.4285575	10.5714425	59
2	9.4139381	9.9848760	0.5860519	0.0151240	58	2	9.4290621	10.5709379	58
3	9.4144082	9.9848420	0.5855918	0.0151580	57	3	9.4295661	10.5704339	57
4	9.4148778	9.9848081	0.5851222	0.0151919	56	4	9.4300697	10.5699303	56
5	9.4153468	9.9847740	0.5846532	0.0152260	55	5	9.4305727	10.5694273	55
6	9.4158152	9.9847400	0.5841848	0.0152600	54	6	9.4310753	10.5689247	54
7	9.4162832	9.9847059	0.5837168	0.0152941	53	7	9.4315773	10.5684227	53
8	9.4167506	9.9846717	0.5832494	0.0153283	52	8	9.4320789	10.5679211	52
9	9.4172174	9.9846375	0.5827826	0.0153625	51	9	9.4325799	10.5674201	51
10	9.4176837	9.9846033	0.5823163	0.0153970	50	10	9.4330804	10.5669196	50
11	9.4181495	9.9845690	0.5818505	0.0154310	49	11	9.4335805	10.5664195	49
12	9.4186148	9.9845347	0.5813852	0.0154653	48	12	9.4340800	10.5659200	48
13	9.4190795	9.9845004	0.5809205	0.0154996	47	13	9.4345791	10.5654209	47
14	9.4195436	9.9844660	0.5804564	0.0155340	46	14	9.4350776	10.5649224	46
15	9.4200073	9.9844316	0.5799927	0.0155684	45	15	9.4355757	10.5644242	45
16	9.4204704	9.9843971	0.5795296	0.0156029	44	16	9.4360733	10.5639267	44
17	9.4209330	9.9843625	0.5790670	0.0156374	43	17	9.4365704	10.5634296	43
18	9.4213950	9.9843281	0.5786050	0.0156719	42	18	9.4370670	10.5629330	42
19	9.4218566	9.9842935	0.5781434	0.0157065	41	19	9.4375630	10.5624369	41
20	9.4223176	9.9842539	0.5776824	0.0157411	40	20	5.4380587	10.5619413	40
21	9.4227780	9.9842242	0.5772220	0.0157758	39	21	9.4385538	10.5614462	39
22	9.4232380	9.9841895	0.5767620	0.0158105	38	22	9.4390485	10.5609515	38
23	9.4236974	9.9841548	0.5763026	0.0158452	37	23	9.4395426	10.5604574	37
24	9.4241563	9.9841200	0.5758437	0.0158800	36	24	9.4400363	10.5599637	36
25	9.4246147	9.9840852	0.5753853	0.0159148	35	25	9.4405295	10.5594705	35
26	9.4250726	9.9840503	0.5749274	0.0159497	34	26	9.4410222	10.5589778	34
27	9.4255299	9.9840154	0.5744701	0.0159846	33	27	9.4415145	10.5584855	33
28	9.4259867	9.9839805	0.5740133	0.0160195	32	28	9.4420062	10.5579938	32
29	9.4264430	9.9839455	0.5735570	0.0160545	31	29	9.4424975	10.5575025	31
30	9.4268988	9.9839105	0.5731012	0.0160895	30	30	9.4429883	10.5570117	30
31	9.4273541	9.9838754	0.5726459	0.0161245	29	31	9.4434786	10.5565214	29
32	9.4278089	9.9838404	0.5721911	0.0161596	28	32	9.4439685	10.5560315	28
33	9.4282631	9.9838052	0.5717369	0.0161948	27	33	9.4444579	10.5555421	27
34	9.4287169	9.9837701	0.5712831	0.0162299	26	34	9.4449468	10.5550532	26
35	9.4291701	9.9837348	0.5708299	0.0162652	25	35	9.4454352	10.5545648	25
36	9.4296228	9.9836996	0.5703772	0.0163004	24	36	9.4459232	10.5540768	24
37	9.4300750	9.9836643	0.5699250	0.0163357	23	37	9.4464107	10.5535893	23
38	9.4305267	9.9836290	0.5694733	0.0163710	22	38	9.4468978	10.5531022	22
39	9.4309779	9.9835936	0.5690221	0.0164064	21	39	9.4473843	10.5526157	21
40	9.4314286	9.9835582	0.5685714	0.0164418	20	40	9.4478704	10.5521296	20
41	9.4318788	9.9835227	0.5681212	0.0164773	19	41	9.4483501	10.5516439	19
42	9.4323285	9.9834872	0.5676715	0.0165128	18	42	9.4488413	10.5511587	18
43	9.4327777	9.9834517	0.5672223	0.0165483	17	43	9.4493260	10.5506740	17
44	9.4332264	9.9834161	0.5667736	0.0165839	16	44	9.4498102	10.5501898	16
45	9.4336746	9.9833805	0.5663254	0.0166195	15	45	9.4502940	10.5497060	15
46	9.4341223	9.9833449	6.5658777	0.0166551	14	46	9.4507774	10.5492226	14
47	9.4345694	9.9833092	0.5654306	0.0166908	13	47	9.4512602	10.5487398	13
48	9.4350161	9.9832735	0.5649836	0.0167265	12	48	9.4517427	10.5482573	12
49	9.4354623	9.9832377	0.5645377	0.0167623	11	49	9.4522246	10.5477754	11
50	9.4359080	9.9832019	0.5640920	0.0167981	10	50	9.4527061	10.5472939	10
51	9.4363532	9.9831661	0.5636468	0.0168339	9	51	9.4531872	10.5468128	9
52	9.4367980	9.9831302	0.5632020	0.0168698	8	52	9.4536678	10.5463322	8
53	9.4372422	9.9830942	0.5627578	0.0169058	7	53	9.4541479	10.5458521	7
54	9.4376859	9.9830583	0.5623141	0.0169417	6	54	9.4546276	10.5453724	6
55	9.4381292	9.9830223	0.5618708	0.0169777	5	55	9.4551069	10.5448931	5
56	9.4385719	9.9829862	0.5614281	0.0170138	4	56	9.4555857	10.5444143	4
57	9.4390142	9.9829501	0.5609858	0.0170499	3	57	9.4560641	10.5439359	3
58	9.4394560	9.9829140	0.5605440	0.0170860	2	58	9.4565420	10.5434580	2
59	9.4398973	9.9828778	0.5601027	0.0171222	1	59	9.4570194	10.5429806	1
60	9.4403381	9.9828416	0.5596619	0.0171586	0	60	9.4574964	10.5425030	0
			Co. Arith.	Sign.				Tangent.	

D.	Sign.	Co. Arith.				D.	Tangent.		
0	9.4403381	9.9828416	0.5596619	0.0171584	60	0	9.4574964	10.5425036	60
1	9.4407784	9.9828054	0.5592216	0.0171946	59	1	9.4579730	10.5420270	59
2	9.4412182	9.9827691	0.5587818	0.0172309	58	2	9.4584491	10.5415509	58
3	9.4416575	9.9827328	0.5583424	0.0172672	57	3	9.4589248	10.5410752	57
4	9.4420965	9.9826964	0.5579035	0.0173036	56	4	9.4594001	10.5405999	56
5	9.4425349	9.9826600	0.5574651	0.0173400	55	5	9.4598749	10.5401251	55
6	9.4429728	9.9826236	0.5570272	0.0173764	54	6	9.4603492	10.5396508	54
7	9.4434103	9.9825871	0.5565897	0.0174129	53	7	9.4608232	10.5391768	53
8	9.4438472	9.9825506	0.5561528	0.0174494	52	8	9.4612967	10.5387033	52
9	9.4442837	9.9825140	0.5557163	0.0174860	51	9	9.4617697	10.5382303	51
10	9.4447197	9.9824774	0.5552803	0.0175226	50	10	9.4622423	10.5377577	50
11	9.4451553	9.9824408	0.5548447	0.0175592	49	11	9.4627145	10.5372855	49
12	9.4455904	9.9824041	0.5544096	0.0175959	48	12	9.4631863	10.5368137	48
13	9.4460250	9.9823674	0.5539750	0.0176326	47	13	9.4636576	10.5363424	47
14	9.4464591	9.9823306	0.5535409	0.0176694	46	14	9.4641285	10.5358715	46
15	9.4468927	9.9822938	0.5531073	0.0177062	45	15	9.4645990	10.5354010	45
16	9.4473259	9.9822569	0.5526741	0.0177431	44	16	9.4650690	10.5349310	44
17	9.4477586	9.9822201	0.5522414	0.0177599	43	17	9.4655386	10.5344614	43
18	9.4481909	9.9821831	0.5518091	0.0178169	42	18	9.4660078	10.5339922	42
19	9.4486227	9.9821462	0.5513773	0.0178538	41	19	9.4664765	10.5335235	41
20	9.4490540	9.9821092	0.5509460	0.0178908	40	20	5.4669448	10.5330552	40
21	9.4494849	9.9820721	0.5505151	0.0179279	39	21	9.4674127	10.5325873	39
22	9.4499153	9.9820351	0.5500847	0.0179649	38	22	9.4678802	10.5321198	38
23	9.4503452	9.9819979	0.5496548	0.0180021	37	23	9.4683473	10.5316527	37
24	9.4507747	9.9819608	0.5492253	0.0180392	36	24	9.4688139	10.5311861	36
25	9.4512037	9.9819236	0.5487963	0.0180764	35	25	9.4692801	10.5307199	35
26	9.4516322	9.9818863	0.5483678	0.0181137	34	26	9.4697459	10.5302541	34
27	9.4520603	9.9818490	0.5479397	0.0181510	33	27	9.4702112	10.5297888	33
28	9.4524879	9.9818117	0.5475121	0.0181883	32	28	9.4706762	10.5293238	32
29	9.4529151	9.9817744	0.5470849	0.0182256	31	29	9.4711407	10.5288993	31
30	9.4533418	9.9817370	0.5466582	0.0182630	30	30	9.4716048	10.5283952	30
31	9.4537681	9.9816995	0.5462319	0.0183005	29	31	9.4720685	10.5279315	29
32	9.4541939	9.9816620	0.5458061	0.0183380	28	32	9.4725318	10.5274682	28
33	9.4546192	9.9816245	0.5453808	0.0183755	27	33	9.4729947	10.5270053	27
34	9.4550441	9.9815870	0.5449559	0.0184130	26	34	9.4734572	10.5265428	26
35	9.4554786	9.9815494	0.5445314	0.0184506	25	35	9.4739192	10.5260808	25
36	9.4558926	9.9815117	0.5441074	0.0184883	24	36	9.4743808	10.5256191	24
37	9.4563161	9.9814740	0.5436839	0.0185260	23	37	9.4748421	10.5251579	23
38	9.4567392	9.9814363	0.5432608	0.0185637	22	38	9.4753029	10.5246971	22
39	9.4571618	9.9813986	0.5428382	0.0186014	21	39	9.4757633	10.5242367	21
40	9.4575840	9.9813608	0.5424160	0.0186392	20	40	9.4762233	10.5237767	20
41	9.4580058	9.9813229	0.5419942	0.0186771	19	41	9.4766829	10.5233171	19
42	9.4584271	9.9812850	0.5415729	0.0187150	18	42	9.4771421	10.5228579	18
43	9.4588480	9.9812471	0.5411520	0.0187529	17	43	9.4776009	10.5223991	17
44	9.4592684	9.9812091	0.5407316	0.0187909	16	44	9.4780592	10.5219408	16
45	9.4596884	9.9811711	0.5403116	0.0188289	15	45	9.4785172	10.5214828	15
46	9.4601079	9.9811331	0.5398921	0.0188669	14	46	9.4789748	10.5210252	14
47	9.4605270	9.9810950	0.5394730	0.0189050	13	47	9.4794319	10.5205681	13
48	9.4609456	9.9810569	0.5390544	0.0189431	12	48	9.4798887	10.5201113	12
49	9.4613638	9.9810187	0.5386362	0.0189813	11	49	9.4803451	10.5196549	11
50	9.4617816	9.9809805	0.5382184	0.0190195	10	50	9.4808011	10.5191989	10
51	9.4621989	9.9809423	0.5378011	0.0190577	9	51	9.4812566	10.5187434	9
52	9.4626158	9.9809040	0.5373842	0.0190960	8	52	9.4817118	10.5182882	8
53	9.4630323	9.9808657	0.5369677	0.0191343	7	53	9.4821666	10.5178334	7
54	9.4634483	9.9808273	0.5365517	0.0191727	6	54	9.4826210	10.5173790	6
55	9.4638639	9.9807889	0.5361361	0.0192111	5	55	9.4830750	10.5169250	5
56	9.4642790	9.9807505	0.5357210	0.0192495	4	56	9.4835286	10.5164714	4
57	9.4646938	9.9807120	0.5353062	0.0192880	3	57	9.4839818	10.5160182	3
58	9.4651081	9.9806735	0.5348919	0.0193265	2	58	9.4844345	10.5155654	2
59	9.4655219	9.9806349	0.5344781	0.0193651	1	59	9.4848870	10.5151130	1
60	9.4659353	9.9805963	0.5340647	0.0194037	0	60	9.4853390	10.5146610	0
			Co, Arith.	Sign.				Tangent.	

M.	Sign.	Co. Arith.					Tangent.		
0	9.4659353	9.9805963	0.5340647	0.0194037	60	0	9.4853390	10.5146610	60
1	9.4663483	9.9805577	0.5336517	0.0194423	59	1	9.4857907	10.5142093	59
2	9.4667509	9.9805190	0.5332391	0.0194810	58	2	9.4862419	10.5137581	58
3	9.4671730	9.9804803	0.5328270	0.0195197	57	3	9.4866928	10.5133072	57
4	9.4675848	9.9804415	0.5324152	0.0195585	56	4	9.4871433	10.5128567	56
5	9.4679960	9.9804027	0.5320040	0.0195973	55	5	9.4875933	10.5124067	55
6	9.4684069	9.9803639	0.5315931	0.0196361	54	6	9.4880430	10.5119570	54
7	9.4688173	9.9803250	0.5311827	0.0196750	53	7	9.4884924	10.5115076	53
8	9.4692273	9.9802860	0.5307727	0.0197140	52	8	9.4889413	10.5110587	52
9	9.4696369	9.9802471	0.5303631	0.0197529	51	9	9.4893898	10.5106102	51
10	9.4700461	9.9802081	0.5299539	0.0197919	50	10	9.4898380	10.5101620	50
11	9.4704548	9.5801690	0.5295452	0.0198310	49	11	9.4902858	10.5097142	49
12	9.4708631	9.9801299	0.5291369	0.0198701	48	12	9.4907332	10.5092668	48
13	9.4712710	9.9800908	0.5287290	0.0199092	47	13	9.4911802	10.5088198	47
14	9.4716785	9.9800516	0.5283215	0.0199484	46	14	9.4916269	10.5083731	46
15	9.4720856	9.9800124	0.5279144	0.0199876	45	15	9.4920731	10.5079269	45
16	9.4724922	9.9799732	0.5275078	0.0200268	44	16	9.4925190	10.5074810	44
17	9.4728985	9.9799339	0.5271015	0.0200661	43	17	9.4929646	10.5070354	43
18	9.4733043	9.9798946	0.5266957	0.0201054	42	18	9.4934097	10.5065903	42
19	9.4737097	9.9798552	0.5262903	0.0201448	41	19	9.4938545	10.5061455	41
20	9.4741146	9.9798158	0.5258854	0.0201842	40	20	9.4942988	10.5057012	40
21	9.4745192	9.9797764	0.5254808	0.0202236	39	21	9.4947429	10.5052571	39
22	9.4749234	9.9797369	0.5250766	0.0202631	38	22	9.4951865	10.5048135	38
23	9.4753271	9.9796973	0.5246729	0.0203027	37	23	9.4956298	10.5043702	37
24	9.4757304	9.9796578	0.5242696	0.0203422	36	24	9.4960727	10.5039273	36
25	9.4761334	9.9796182	0.5238666	0.0203818	35	25	9.4965152	10.5034848	35
26	9.4765359	9.9795785	0.5234641	0.0204215	34	26	9.4969574	10.5030426	34
27	9.4769380	9.9795388	0.5230620	0.0204612	33	27	9.4973991	10.5026009	33
28	9.4773396	9.9794991	0.5226604	0.0205009	32	28	9.4978406	10.5021594	32
29	9.4777409	9.9794593	0.5222591	0.0205407	31	29	9.4982816	10.5017184	31
30	9.4781418	9.9794195	0.5218582	0.0205805	30	30	9.4987223	10.5012777	30
31	9.4785423	9.9793796	0.5214577	0.0206204	29	31	9.4991626	10.5008374	29
32	9.4789423	9.9793398	0.5210577	0.0206602	28	32	9.4996026	10.5003974	28
33	9.4793420	9.9792998	0.5206580	0.0207002	27	33	9.5000422	10.4999578	27
34	9.4797412	9.9792599	0.5202588	0.0207402	26	34	9.5004814	10.4995187	26
35	9.4801401	9.9792198	0.5198599	0.0207802	25	35	9.5009203	10.4990796	25
36	9.4805385	9.9751798	0.5194615	0.0208202	24	36	9.5013588	10.4986412	24
37	9.4809366	9.9791397	0.5190634	0.0208603	23	37	9.5017969	10.4982031	23
38	9.4813342	9.9790996	0.5186658	0.0209004	22	38	9.5022347	10.4977653	22
39	9.4817315	9.9790594	0.5182685	0.0209406	21	39	9.5026721	10.4973279	21
40	9.4821283	9.9790192	0.5178717	0.0209808	20	40	9.5031092	10.4968908	20
41	9.4825248	9.9789789	0.5174752	0.0210211	19	41	9.5035459	10.4964541	19
42	9.4829208	9.9789386	0.5170792	0.0210614	18	42	9.5039822	10.4960178	18
43	9.4833165	9.9788983	0.5166835	0.0211017	17	43	9.5044182	10.4955818	17
44	9.4837117	9.9788580	0.5162883	0.0211421	16	44	9.5048538	10.4951462	16
45	9.4841066	9.5788175	0.5158934	0.0211825	15	45	9.5052891	10.4947109	15
46	9.4845010	9.9787770	0.5154990	0.0212230	14	46	9.5057240	10.4942760	14
47	9.4848951	9.9787365	0.5151049	0.0212635	13	47	9.5061586	10.4938414	13
48	9.4852888	9.9786960	0.5147112	0.0213040	12	48	9.5065928	10.4934072	12
49	9.4856820	9.9786554	0.5143180	0.0213446	11	49	9.5070267	10.4929733	11
50	9.4860739	9.9786148	0.5139251	0.0213852	10	50	9.5074602	10.4925398	10
51	9.4864674	9.9785741	0.5135326	0.0214259	9	51	9.5078933	10.4921067	9
52	9.4868595	9.9785334	0.5131405	0.0214666	8	52	9.5083261	10.4916739	8
53	9.4872512	9.9784927	0.5127488	0.0215073	7	53	9.5087586	10.4912414	7
54	9.4876416	9.9784519	0.5123574	0.0215481	6	54	9.5091907	10.4908093	6
55	9.4880335	9.9784111	0.5119665	0.0215889	5	55	9.5096224	10.4903776	5
56	9.4884240	9.9783702	0.5115760	0.0216298	4	56	9.5100539	10.4899461	4
57	9.4888142	9.9783293	0.5111858	0.0216707	3	57	9.5104849	10.4895151	3
58	9.4892040	9.9782883	0.5107960	0.0217117	2	58	9.5109156	10.4890844	2
59	9.4895934	9.9782474	0.5104066	0.0217526	1	59	9.5113460	10.4886540	1
60	9.4899824	9.9782063	0.5100176	0.0217937	0	60	9.5117460	10.4882240	0
			Co. Arith.	Sign.				Tangent.	

Degrees 18.

M.	Sign.	Co. Arith.					Tangent.		
0	9.4899824	9.9782063	0.5100176	0.0217397	60	0	9.5117760	10.4882240	60
1	9.4903710	9.9781653	0.5096290	0.0218347	59	1	9.5122057	10.4877943	59
2	9.4907592	9.9781241	0.5092408	0.0218759	58	2	9.5126351	10.4873649	58
3	9.4911471	9.9780830	0.5088529	0.0219170	57	3	9.5130641	10.4869359	57
4	9.4915345	9.9780418	0.5084655	0.0219582	56	4	9.5134927	10.4865073	56
5	9.4919216	9.9780006	0.5080784	0.0219994	55	5	9.5139210	10.4860790	55
6	9.4923083	9.9779593	0.5076917	0.0220407	54	6	9.5143490	10.4856510	54
7	9.4926946	9.9779180	0.5073054	0.0220820	53	7	9.5147796	10.4852234	53
8	9.4930806	9.9778766	0.5069194	0.0221234	52	8	9.5152039	10.4847961	52
9	9.4934661	9.9778353	0.5065339	0.0221647	51	9	9.5156309	10.4843691	51
10	9.4938513	9.9777930	0.5061487	0.0222062	50	10	9.5160575	10.4839425	50
11	9.4942361	9.5777523	0.5057639	0.0222477	49	11	9.5164838	10.4835162	49
12	9.4946205	9.9777108	0.5053795	0.0222892	48	12	9.5169097	10.4830903	48
13	9.4950046	9.9776693	0.5049954	0.0223307	47	13	9.5173353	10.4826647	47
14	9.4953883	9.9776277	0.5046117	0.0223723	46	14	9.5177606	10.4822394	46
15	9.4957716	9.9775860	0.5042284	0.0224140	45	15	9.5181855	10.4818145	45
16	9.4961545	9.9775444	0.5038455	0.0224556	44	16	9.5186101	10.4813899	44
17	9.4965370	9.9775026	0.5034630	0.0224974	43	17	9.5190344	10.4809656	43
18	9.4969192	9.9774609	0.5030808	0.0225391	42	18	9.5194583	10.4805417	42
19	9.4973010	9.9774191	0.5026990	0.0225809	41	19	9.5198819	10.4801141	41
20	9.4976824	9.9773772	0.5023176	0.0226228	40	20	9.5203052	10.4796998	40
21	9.4980635	9.9773354	0.5019365	0.0226645	39	21	9.5207282	10.4792718	39
22	9.4984442	9.9772934	0.5015558	0.0227066	38	22	9.5211508	10.4788492	38
23	9.4988245	9.9772515	0.5011755	0.0227485	37	23	9.5215730	10.4784270	37
24	9.4992049	9.9772095	0.5007955	0.0227905	36	24	9.5219950	10.4780050	36
25	9.4995840	9.9771674	0.5004160	0.0228326	35	25	9.5224166	10.4775834	35
26	9.4999633	9.9771253	0.5000367	0.0228747	34	26	9.5228379	10.4771621	34
27	9.5003421	9.9770832	0.4996579	0.0229168	33	27	9.5232589	10.4767411	33
28	9.5007206	9.9770410	0.4992794	0.0229590	32	28	9.5236795	10.4763205	32
29	9.5010987	9.9769988	0.4989013	0.0230012	31	29	9.5240999	10.4759001	31
30	9.5014764	9.9769566	0.4985236	0.0230434	30	30	9.5245199	10.4754801	30
31	9.5018538	9.9769143	0.4981462	0.0230857	29	31	9.5249395	10.4750605	29
32	9.5622308	9.9768720	0.4977692	0.0231280	28	32	9.5253589	10.4746411	28
33	9.5026075	9.9768296	0.4973925	0.0231704	27	33	9.5257779	10.4742221	27
34	9.5039838	9.9767872	0.4970162	0.0232128	26	34	9.5261966	10.4738034	26
35	9.5033597	9.9767447	0.4966403	0.0232553	25	35	9.5266150	10.4733850	25
36	9.5037353	9.9767012	0.4962647	0.0232978	24	36	9.5270331	10.4729669	24
37	9.5041105	9.9766597	0.4958895	0.0233403	23	37	9.5274508	10.4725492	23
38	9.5044853	9.9766171	0.4955147	0.0233829	22	38	9.5278682	10.4721318	22
39	9.5048598	9.9765745	0.4951402	0.0234255	21	39	9.5282854	10.4717147	21
40	9.5052339	9.9765318	0.4947661	0.0234682	20	40	9.5287021	10.4712979	20
41	9.5056077	9.9764891	0.4943923	0.0235109	19	41	9.5291186	10.4708814	19
42	9.5059811	9.9764464	0.4940189	0.0235536	18	42	9.5295347	10.4704653	18
43	9.5063542	9.9764036	0.4936458	0.0235964	17	43	9.5299505	10.4700495	17
44	9.5067269	9.9763608	0.4932731	0.0236392	16	44	9.5303661	10.4696339	16
45	9.5070992	9.5763179	0.4929008	0.0236820	15	45	9.5307813	10.4692187	15
46	9.5074712	9.9762750	0.4925288	0.0237250	14	46	9.5314961	10.4688039	14
47	9.5078428	9.9762321	0.4921572	0.0237679	13	47	9.5316107	10.4683893	13
48	9.5082141	9.9761891	0.4917859	0.0238109	12	48	9.5320250	10.4679750	12
49	9.5085850	9.9761461	0.4914150	0.0238539	11	49	9.5324389	10.4675611	11
50	9.5089556	9.9761030	0.4910444	0.0238970	10	50	9.5328526	10.4671474	10
51	9.5093258	9.9760599	0.4906742	0.0239401	9	51	9.5332659	10.4667341	9
52	9.5096956	9.9760167	0.4903044	0.0239833	8	52	9.5336789	10.4663211	8
53	9.5100651	9.9759736	0.4899349	0.0240264	7	53	9.5340916	10.4659084	7
54	9.5104343	9.9759303	0.4895657	0.0240697	6	54	9.5345040	10.4654960	6
55	9.5108031	9.9758870	0.4891969	0.0241130	5	55	9.5349161	10.4650839	5
56	9.5111716	9.9758437	0.4888284	0.0241563	4	56	9.5353278	10.4646722	4
57	9.5115397	9.9758004	0.4884603	0.0241996	3	57	9.5357393	10.4642607	3
58	9.5119074	9.9757570	0.4880926	0.0242430	2	58	9.5361505	10.4638495	2
59	9.51227[illegible]9	9.9757135	0.4877251	0.0242865	1	59	9.5365613	10.4634387	1
60	9.5126419	9.9756701	0.4873581	0.0243299	0	60	9.5369719	10.4630281	0
			Co. Arith.	Sign.				Tangent.	

Degrees 71.

M.	Sign.	Co. Arith.					Tangent.		
0	9.5126419	9.9756701	0.4873581	0.0243299	60	0	9.5369719	10.4630281	60
1	9.5130086	9.9756265	0.4869914	0.0243735	59	1	9.5373821	10.4626179	59
2	9.5133750	9.9755830	0.4866250	0.0244170	58	2	9.5377920	10.4622080	58
3	9.5137410	9.9755394	0.4862590	0.0244606	57	3	9.5382017	10.4617983	57
4	9.5141067	9.9754957	0.4858933	0.0245043	56	4	9.5386110	10.4613890	56
5	9.5144721	9.9754521	0.4855279	0.0245479	55	5	9.5390200	10.4609800	55
6	9.5148371	9.9754083	0.4851629	0.0245917	54	6	9.5394287	10.4605713	54
7	9.5152017	9.9753646	0.4847983	0.0246354	53	7	9.5398371	10.4601629	53
8	9.5155660	9.9753208	0.4844340	0.0246792	52	8	9.5402453	10.4597547	52
9	9.5159300	9.9752769	0.4840700	0.0247231	51	9	9.5406531	10.4593469	51
10	9.5162936	9.9752330	0.4837064	0.0247670	50	10	9.5410606	10.4589394	50
11	9.5166569	9.9751891	0.4833431	0.0248109	49	11	9.5414678	10.4585322	49
12	9.5170198	9.9751451	0.4829802	0.0248549	48	12	9.5418747	10.4581253	48
13	9.5173824	9.9751010	0.4826176	0.0248989	47	13	9.5422813	10.4577187	47
14	9.5177447	9.9750570	0.4822553	0.0249430	46	14	9.5426877	10.4573123	46
15	9.5181066	9.9750129	0.4818934	0.0249871	45	15	9.5430937	10.4569063	45
16	9.5184682	9.9749688	0.4815318	0.0250312	44	16	9.5434994	10.4565006	44
17	9.5188295	9.9749246	0.4811705	0.0250754	43	17	9.5439048	10.4560952	43
18	9.5191904	9.9748804	0.4808096	0.0251196	42	18	9.5443100	10.4556900	42
19	9.5195510	9.9748361	0.4804490	0.0251639	41	19	9.5447148	10.4552852	41
20	9.5199112	9.9747918	0.4800888	0.0252082	40	20	9.5451193	10.4548807	40
21	9.5202711	9.9747475	0.4797289	0.0252525	39	21	9.5455236	10.4544764	39
22	9.5206307	9.9747031	0.4793693	0.0252969	38	22	9.5459276	10.4540724	38
23	9.5209899	9.9746587	0.4790101	0.0253413	37	23	9.5463312	10.4536688	37
24	9.5213488	9.9746142	0.4786512	0.0253858	36	24	9.5467345	10.4532654	36
25	9.5217074	9.9745697	0.4782926	0.0254303	35	25	9.5471377	10.4528623	35
26	9.5220656	9.9745251	0.4779344	0.0254748	34	26	9.5475405	10.4524595	34
27	9.5224235	9.9744806	0.4775765	0.0255194	33	27	9.5479430	10.4520570	33
28	9.5227811	9.9744359	0.4772189	0.0255641	32	28	9.5483452	10.4516548	32
29	9.5231383	9.9743913	0.4768617	0.0256087	31	29	9.5487471	10.4512529	31
30	9.5234053	9.9743456	0.4765047	0.0256534	30	30	9.5491487	10.4508513	30
31	9.5238518	9.9743018	0.4761482	0.0256982	29	31	9.5495500	10.4504500	29
32	9.5242081	9.9742570	0.4757919	0.0257430	28	32	9.5499511	10.4500489	28
33	9.5245640	9.9742122	0.4754360	0.0257878	27	33	9.5503519	10.4496481	27
34	9.5249196	9.9741673	0.4750804	0.0258327	26	34	9.5507523	10.4492477	26
35	9.5252749	9.9741224	0.4747251	0.0258776	25	35	9.5511525	10.4488475	25
36	9.5256298	9.9740774	0.4743702	0.0259226	24	36	9.5515524	10.4484476	24
37	9.5259844	9.9740324	0.4740156	0.0259676	23	37	9.5519521	10.4480479	23
38	9.5263387	9.9739873	0.4736613	0.0260127	22	38	9.5523514	10.4476486	22
39	9.5266927	9.9739422	0.4733073	0.0260578	21	39	9.5527504	10.4472496	21
40	9.5270463	9.9738971	0.4729537	0.0261029	20	40	9.5531492	10.4468508	20
41	9.5273997	9.9738519	0.4726003	0.0261481	19	41	9.5535477	10.4464523	19
42	9.5277526	9.9738067	0.4722474	0.0261933	18	42	9.5539459	10.4460541	18
43	9.5281053	9.9737615	0.4718947	0.0262385	17	43	9.5543438	10.4456562	17
44	9.5284577	9.9737162	0.4715423	0.0262838	16	44	9.5547415	10.4452585	16
45	9.5288097	9.9736709	0.4711903	0.0263291	15	45	9.5551388	10.4448612	15
46	9.5291614	9.9736255	0.4708386	0.0263745	14	46	9.5555359	10.4444641	14
47	9.5295128	9.9735801	0.4704872	0.0264199	13	47	9.5559327	10.4440673	13
48	9.5298638	9.9735345	0.4701362	0.0264654	12	48	9.5563292	10.4436708	12
49	9.5302145	9.9734891	0.4697854	0.0265109	11	49	9.5567255	10.4432745	11
50	9.5305650	9.9734435	0.4694350	0.0265565	10	50	9.5571214	10.4428786	10
51	9.5309151	9.9733980	0.4690849	0.0266020	9	51	9.5575171	10.4424829	9
52	9.5312649	9.9733523	0.4687351	0.0266477	8	52	9.5579125	10.4420875	8
53	9.5316143	9.9733067	0.4683857	0.0266933	7	53	9.5583077	10.4416923	7
54	9.5319635	9.9732610	0.4680365	0.0267390	6	54	9.5587025	10.4412975	6
55	9.5323123	9.9732152	0.4676877	0.0267848	5	55	9.5590971	10.4409029	5
56	9.5326608	9.9731694	0.4673392	0.0268306	4	56	9.5594914	10.4405086	4
57	9.5330090	9.9731236	0.4669910	0.0268764	3	57	9.5598854	10.4401146	3
58	9.5333559	9.9730777	0.4666431	0.0269223	2	58	9.5602792	10.4397208	2
59	9.5337044	9.9730318	0.4662956	0.0269682	1	59	9.5606727	10.4393273	1
60	9.5349517	9.9729858	0.4659483	0.0270142	0	60	9.5610659	10.4389341	0
			Co. Arith.	Sign.				Tangent	

M.	Sign.	Co. Arith.					Tangent.		
0	9.5340517	9.9729858	0.4659483	0.0270142	60	0	9.5610659	10.4389341	60
1	9.5343986	9.9729398	0.4656014	0.0270602	59	1	9.5614588	10.4385412	59
2	9.5347452	9.9728933	0.4652548	0.0271062	58	2	9.5618515	10.4381485	58
3	9.5350915	9.9728477	0.4649085	0.0271523	57	3	9.5622439	10.4377561	57
4	9.5354375	9.9728016	0.4645625	0.0271984	56	4	9.5626360	10.4373640	56
5	9.5357832	9.9727554	0.4642168	0.0272446	55	5	9.5630278	10.4369722	55
6	9.5361286	9.9727092	0.4638714	0.0272908	54	6	9.5634194	10.4365806	54
7	9.5364737	9.9726629	0.4635263	0.0273371	53	7	9.5638107	10.4361893	53
8	9.5368184	9.9726166	0.4631816	0.0273834	52	8	9.5642018	10.4357982	52
9	9.5371628	9.9725703	0.4628372	0.0274297	51	9	9.5645925	10.4354075	51
10	9.5375070	9.9725239	0.4624930	0.0274761	50	10	9.5649831	10.4350169	50
11	9.5378508	9.9724775	0.4621492	0.0275225	49	11	9.5653733	10.4346267	49
12	9.5381943	9.9724310	0.4618057	0.0275690	48	12	9.5657633	10.4342367	48
13	9.5385375	9.9723845	0.4614625	0.0276155	47	13	9.5661530	10.4338470	47
14	9.5388804	9.9723380	0.4611196	0.0276620	46	14	9.5665424	10.4334576	46
15	9.5392230	9.9722914	0.4607770	0.0277086	45	15	9.5669316	10.4330684	45
16	9.5395653	9.9722448	0.4604347	0.0277552	44	16	9.5673205	10.4326795	44
17	9.5399073	9.9721981	0.4600927	0.0278019	43	17	9.5677091	10.4322909	43
18	9.5402489	9.9721514	0.4597511	0.0278486	42	18	9.5680975	10.4319025	42
19	9.5405903	9.9721047	0.4594097	0.0278954	41	19	9.5684856	10.4315144	41
20	9.5409314	9.9720579	0.4590686	0.0279421	40	20	5.5688735	10.4311365	40
21	9.5412721	9.9720110	0.4587279	0.0279890	39	21	9.5692611	10.4307389	39
22	9.5416126	9.9719642	0.4583874	0.0280358	38	22	9.5696484	10.4303516	38
23	9.5419527	9.9719172	0.4580473	0.0280828	37	23	9.5700355	10.4299645	37
24	9.5422926	9.9718703	0.4577074	0.0281297	36	24	9.5704223	10.4295777	36
25	9.5426321	9.9718233	0.4573679	0.0281767	35	25	9.5708088	10.4291912	35
26	9.5429713	9.9717762	0.4570287	0.0282238	34	26	9.5711951	10.4288049	34
27	9.5433103	9.9717291	0.4566897	0.0282709	33	27	9.5715811	10.4284189	33
28	9.5436489	9.9716820	0.4563511	0.0283180	32	28	9.5719669	10.4280331	32
29	9.5439873	9.9716348	0.4560127	0.0283652	31	29	9.5723524	10.4276476	31
30	9.5443253	9.9715876	0.4556747	0.0284124	30	30	9.5727377	10.4272623	30
31	9.5446630	9.9715404	0.4553370	0.0284596	29	31	9.5731227	10.4268773	29
32	9.5450005	9.9714931	0.4549995	0.0285069	28	32	9.5735074	10.4264926	28
33	9.5453376	9.9714457	0.4546624	0.0285543	27	33	9.5738919	10.4261081	27
34	9.5456745	9.9713984	0.4543255	0.0286016	26	34	9.5742761	10.4257239	26
35	9.5460110	9.9713509	0.4539890	0.0286491	25	35	9.5746601	10.4253399	25
36	9.5463472	9.9713035	0.4536528	0.0286965	24	36	9.5750438	10.4249562	24
37	9.5466832	9.9712560	0.4533168	0.0287440	23	37	9.5754272	10.4245728	23
38	9.5470189	9.9712084	0.4529811	0.0287916	22	38	9.5758104	10.4241896	22
39	9.5473542	9.9711608	0.4526458	0.0288392	21	39	9.5761934	10.4238066	21
40	9.5476893	9.9711132	0.4523107	0.0288868	20	40	9.5765761	10.4234239	20
41	9.5480240	9.9710655	0.4519760	0.0289345	19	41	9.5769585	10.4230415	19
42	9.5483585	9.9710178	0.4516415	0.0289822	18	42	9.5773407	10.4226593	18
43	9.5486927	9.9709701	0.4513073	0.0290299	17	43	9.5777226	10.4222774	17
44	9.5490266	9.9709223	0.4509734	0.0290777	16	44	9.5781043	10.4218957	16
45	9.5493602	9.9708744	0.4506398	0.0291256	15	45	9.5784858	10.4215142	15
46	9.5496935	9.9708265	0.4503065	0.0291735	14	46	9.5788669	10.4211331	14
47	9.5500265	9.9707786	0.4499735	0.0292214	13	47	9.5792479	10.4207521	13
48	9.5503592	9.9707306	0.4496408	0.0292694	12	48	9.5896286	10.4203714	12
49	9.5506916	9.9706826	0.4493084	0.0293174	11	49	9.5800090	10.4199910	11
50	9.5510237	9.9706346	0.4489763	0.0293654	10	50	9.5803892	10.4196108	10
51	9.5513556	9.9705865	0.4486444	0.0294135	9	51	9.5807691	10.4192309	9
52	9.5516871	9.9705383	0.4483129	0.0294617	8	52	9.5811488	10.4188512	8
53	9.5520184	9.9704902	0.4479816	0.0295098	7	53	9.5815282	10.4184718	7
54	9.5523494	9.9704419	0.4476506	0.0295581	6	54	9.5819074	10.4180926	6
55	9.5526801	9.9703937	0.4473199	0.0296063	5	55	9.5822864	10.4177136	5
56	9.5530105	9.9703454	0.4469895	0.0296546	4	56	9.5826651	10.4173349	4
57	9.5533406	9.9702970	0.4466594	0.0297030	3	57	9.5830435	10.4169765	3
58	9.5536704	9.9702486	0.4463296	0.0297514	2	58	9.5834217	10.4165783	2
59	9.5539599	9.9702002	0.4460001	0.0297998	1	59	9.5837997	10.4162003	1
60	9.5543292	9.9701517	0.4456708	0.0298483	0	60	9.5841774	10.4158226	0
			Co. Arith.	Sign.				Tangent	

M.	Sign.	Co. Arith.					Tangent.		
0	9.5543292	9.9701517	0.4456708	0.0298483	60	0	9.5841774	10.4118226	60
1	9.5546581	9.9701032	0.4453419	0.0298968	59	1	9.5845549	10.4154451	59
2	9.5549868	9.9700547	0.4450132	0.0299453	58	2	9.5849321	10.4150679	58
3	9.5553152	9.9700061	0.4446848	0.0299939	57	3	9.5853091	10.4146909	57
4	9.5556433	9.9699574	0.4443567	0.0300426	56	4	9.5856859	10.4143141	56
5	9.5559711	9.9699087	0.4440289	0.0300913	55	5	9.5860624	10.4139376	55
6	9.5562989	9.9698600	0.4437011	0.0301400	54	6	9.5864386	10.4135614	54
7	9.5566259	9.9698112	0.4433741	0.0301888	53	7	9.5868147	10.4131853	53
8	9.5569529	9.9697624	0.4430471	0.0302376	52	8	9.5871904	10.4128096	52
9	9.5572796	9.9697136	0.4427204	0.0302864	51	9	9.5875660	10.4124340	51
10	9.5576060	9.9696647	0.4423940	0.0303353	50	10	9.5879413	10.4120587	50
11	9.5579321	9.9696158	0.4420679	0.0303842	49	11	9.5883163	10.4116837	49
12	9.5582579	9.9695668	0.4417421	0.0304332	48	12	9.5886912	10.4113088	48
13	9.5585835	9.9695177	0.4414165	0.0304823	47	13	9.5890657	10.4109343	47
14	9.5589088	9.9694687	0.4410912	0.0305313	46	14	9.5894401	10.4105599	46
15	9.5592338	9.9694196	0.4407662	0.0305804	45	15	9.5898142	10.4101858	45
16	9.5595585	9.9693704	0.4404415	0.0306295	44	16	9.5901881	10.4098119	44
17	9.5598829	9.9693212	0.4401171	0.0306788	43	17	9.5905617	10.4094383	43
18	9.5602071	9.9692720	0.4397929	0.0307280	42	18	9.5909351	10.4090649	42
19	9.5605310	9.9692227	0.4394690	0.0307773	41	19	9.5913082	10.4086918	41
20	9.5608545	9.9691734	0.4391454	0.0308266	40	20	9.5916812	10.4083188	40
21	9.5611779	9.9691241	0.4388221	0.0308759	39	21	9.5920539	10.4079461	39
22	9.5615010	9.9690746	0.4384990	0.0309254	38	22	9.5924263	10.4075737	38
23	9.5618237	9.9690252	0.4381763	0.0309748	37	23	9.5927985	10.4072015	37
24	9.5621462	9.9689757	0.4378538	0.0310243	36	24	9.5931705	10.4068295	36
25	9.5624685	9.9689262	0.4375315	0.0310738	35	25	9.5935423	10.4064577	35
26	9.5627904	9.9688766	0.4372096	0.0311234	34	26	9.5939138	10.4060862	34
27	9.5631121	9.9688270	0.4368879	0.0311730	33	27	9.5942851	10.4057149	33
28	9.5634335	9.9687773	0.4365665	0.0312227	32	28	9.5946561	10.4053439	32
29	9.5637546	9.9687276	0.4362454	0.0312724	31	29	9.5950269	10.4049731	31
30	9.5640754	9.9686779	0.4359246	0.0313221	30	30	9.5953975	10.4046025	30
31	9.5643960	9.9686281	0.4356040	0.0313719	29	31	9.5957679	10.4042321	29
32	9.5647163	9.9685783	0.4352837	0.0314217	28	32	9.5961380	10.4038620	28
33	9.5650363	9.9685284	0.4349637	0.0314716	27	33	9.5965079	10.4034921	27
34	9.5653561	9.9684785	0.4346439	0.0315215	26	34	9.5968776	10.4031224	26
35	9.5656756	9.9684286	0.4343244	0.0315714	25	35	9.5972470	10.4027530	25
36	9.5659948	9.9683786	0.4340052	0.0316214	24	36	9.5976162	10.4023838	24
37	9.5663137	9.9683285	0.4336863	0.0316715	23	37	9.5979852	10.4020148	23
38	9.5666324	9.9682784	0.4333676	0.0317216	22	38	9.5983540	10.4016460	22
39	9.5669508	9.9682283	0.4330492	0.0317717	21	39	9.5987225	10.4012775	21
40	9.5672689	9.9681781	0.4327311	0.0318219	20	40	9.5990608	10.4009092	20
41	9.5675868	9.9681279	0.4324132	0.0318721	19	41	9.5994588	10.4905412	19
42	9.5679044	9.9680777	0.4320956	0.0319223	18	42	9.5998267	10.4901733	18
43	9.5682217	9.9680274	0.4317783	0.0319726	17	43	9.6001943	10.3098057	17
44	9.5685387	9.9679771	0.4314613	0.0320229	16	44	9.6005617	10.3094383	16
45	9.5688555	9.9679267	0.4311445	0.0320733	15	45	9.6009289	10.3090711	15
46	9.5691721	9.9678763	0.4308279	0.0321237	14	46	9.6012958	10.3987042	14
47	9.5694883	9.9678258	0.4305117	0.0321742	13	47	9.6016625	10.3983375	13
48	9.5698043	9.9677753	0.4301957	0.0322247	12	48	9.6020290	10.3979710	12
49	9.5701200	9.9677247	0.4298800	0.0322753	11	49	9.6023953	10.3976047	11
50	9.5704355	9.9676741	0.4295655	0.0323259	10	50	9.6027613	10.3972387	10
51	9.5707506	9.9676235	0.4292494	0.0323765	9	51	9.6031271	10.3968729	9
52	9.5710656	9.9675728	0.4289344	0.0324272	8	52	9.6034937	10.3965073	8
53	9.5713802	9.9675221	0.4286198	0.0324779	7	53	9.6038581	10.3961419	7
54	9.5716946	9.9674713	0.4283054	0.0325287	6	54	9.6042233	10.3957767	6
55	9.5720087	9.9674205	0.4279913	0.0325795	5	55	9.6045882	10.3954118	5
56	9.5723226	9.9673697	0.4276774	0.0326303	4	56	9.6049529	10.3950471	4
57	9.5726362	9.9673188	0.4273638	0.0326812	3	57	9.6053174	10.3946826	3
58	9.5729495	9.9672679	0.4270505	0.0327321	2	58	9.6056817	10.3943183	2
59	9.5732626	9.9672169	0.4267374	0.0327831	1	59	9.6060457	10.3939543	1
60	9.5735754	9.9671659	0.4264246	0.0328341	0	60	9.6064096	10.3935904	0
			Co. Arith.	Sign.				Tangent.	

M.	Sign.	Co. Arith.					Tangent.		
0	9.5735754	9.9671659	0.4264245	0.0328341	60	0	9.6064096	10.3935904	60
1	9.5738880	9.9671148	0.4261120	0.0328852	59	1	9.6067732	10.3932268	59
2	9.5742003	9.9670637	0.4257997	0.0329363	58	2	9.6071366	10.3928634	58
3	9.5745123	9.9670125	0.4254877	0.0329875	57	3	9.6074997	10.3925003	57
4	9.5748240	9.9669614	0.4251760	0.0330386	56	4	9.6078627	10.3921373	56
5	9.5751356	9.9669101	0.4248644	0.0330899	55	5	9.6082254	10.3917746	55
6	9.5754468	9.9668588	0.4245532	0.0331412	54	6	9.6085880	10.3914120	54
7	9.5757573	9.9668075	0.4242422	0.0331925	53	7	9.6089503	10.3910497	53
8	9.5760685	9.9667562	0.4239315	0.0332438	52	8	9.6093124	10.3906876	52
9	9.5763790	9.9667048	0.4236210	0.0332952	51	9	9.6096742	10.3903258	51
10	9.5766892	9.9666533	0.4233108	0.0333467	50	10	9.6100359	10.3899641	50
11	9.5769991	9.9666018	0.4230009	0.0333982	49	11	9.6103973	10.3896027	49
12	9.5773083	9.9665503	0.4226912	0.0334497	48	12	9.6107586	10.3892414	48
13	9.5776183	9.9664987	0.4223817	0.0335013	47	13	9.6111196	10.3888804	47
14	9.5779275	9.9664471	0.4220725	0.0335529	46	14	9.6114804	10.3885196	46
15	9.5782364	9.9663954	0.4217636	0.0336046	45	15	9.6118409	10.3881591	45
16	9.5785450	9.9663437	0.4214550	0.0336563	44	16	9.6122013	10.3877987	44
17	9.5788535	9.9662920	0.4211465	0.0337080	43	17	9.6125615	10.3874385	43
18	9.5791615	9.9662402	0.4208384	0.0337598	42	18	9.6129214	10.3870786	42
19	9.5794695	9.9661884	0.4205305	0.0338116	41	19	9.6132812	10.3867188	41
20	9.5797772	9.9661365	0.4202228	0.0338635	40	20	9.6136407	10.3863593	40
21	9.5800845	9.9660845	0.4199155	0.0339154	39	21	9.6140000	10.3860000	39
22	9.5803917	9.9660326	0.4196083	0.0339674	38	22	9.6143591	10.3856409	38
23	9.5806985	9.9659805	0.4193014	0.0340194	37	23	9.6147180	10.3852820	37
24	9.5810052	9.9659285	0.4189948	0.0340715	36	24	9.6150766	10.3849234	36
25	9.5813116	9.9658764	0.4186884	0.0341236	35	25	9.6154351	10.3845649	35
26	9.5816177	9.9658243	0.4183823	0.0341757	34	26	9.6157934	10.3842066	34
27	9.5819236	9.9657721	0.4180764	0.0342279	33	27	9.6161514	10.3838486	33
28	9.5822292	9.9657199	0.4177708	0.0342801	32	28	9.6165093	10.3834907	32
29	9.5825345	9.9656677	0.4174655	0.0343323	31	29	9.6168669	10.3831331	31
30	9.5828397	9.9656153	0.4171603	0.0343847	30	30	9.6172243	10.3827757	30
31	9.5831445	9.9655630	0.4163555	0.0344370	29	31	9.6175815	10.3824185	29
32	9.5834491	9.9655105	0.4165509	0.0344894	28	32	9.6179385	10.3820615	28
33	9.5837535	9.9654582	0.4162465	0.0345418	27	33	9.6182953	10.3817047	27
34	9.5840576	9.9654057	0.4159424	0.0345943	26	34	9.6186519	10.3813481	26
35	9.5843615	9.9653532	0.4156385	0.0346468	25	35	9.6190083	10.3809917	25
36	9.5846651	9.9653006	0.4153349	0.0346994	24	36	9.6193645	10.3806355	24
37	9.5849685	9.9652480	0.4150315	0.0347520	23	37	9.6197205	10.3802795	23
38	9.5852716	9.9651953	0.4147284	0.0348047	22	38	9.6200762	10.3799238	22
39	9.5855745	9.9651426	0.4144255	0.0348574	21	39	9.6204318	10.3795682	21
40	9.5858771	9.9650899	0.4141229	0.0349101	20	40	9.6207872	10.3792128	20
41	9.5861795	9.9650371	0.4138205	0.0349629	19	41	9.6211423	10.3788577	19
42	9.5864816	9.9649843	0.4135184	0.0350157	18	42	9.6214973	10.3785027	18
43	9.5867835	9.9649314	0.4132165	0.0350686	17	43	9.6218520	10.3781480	17
44	9.5870851	9.9648785	0.4129149	0.0351215	16	44	9.6222066	10.3777934	16
45	9.5873865	9.9648256	0.4126135	0.0351744	15	45	9.6225609	10.3774391	15
46	9.5876876	9.9647726	0.4123124	0.0352274	14	46	9.6229150	10.3770850	14
47	9.5879885	9.9647195	0.4120115	0.0352805	13	47	9.6232690	10.3767310	13
48	9.5882892	9.9646665	0.4117108	0.0353335	12	48	9.6236227	10.3763773	12
49	9.5885896	9.9646133	0.4114104	0.0353867	11	49	9.6239763	10.3760237	11
50	9.5888897	9.9645602	0.4111103	0.0354398	10	50	9.6243296	10.3756704	10
51	9.5891897	9.9645069	0.4108103	0.0354931	9	51	9.6246827	10.3753173	9
52	9.5894893	9.9644537	0.4105107	0.0355463	8	52	9.6250356	10.3749644	8
53	9.5897888	9.9644004	0.4102112	0.0355996	7	53	9.6253884	10.3746116	7
54	9.5900880	9.9643470	0.4099120	0.0356530	6	54	9.6257409	10.3742591	6
55	9.5903869	9.9642937	0.4096131	0.0357063	5	55	9.6260932	10.3739068	5
56	9.5906856	9.9642402	0.4093144	0.0357598	4	56	9.6264454	10.3735546	4
57	9.5909841	9.9641868	0.4090159	0.0358132	3	57	9.6267973	10.3732027	3
58	9.5912823	9.9641332	0.4087177	0.0358668	2	58	9.6271491	10.3728509	2
59	9.5915803	9.9640797	0.4084157	0.0359203	1	59	9.6275006	10.3724994	1
60	9.5918780	9.9640261	0.4081220	0.0359739	0	60	9.6278519	10.3721481	0
			Co. Arith.	Sign.				Tangent.	

Degrees 23.

M.	Sign.	Co. Arith.				M.	Tangent.		
0	9.5918780	9.9640261	0.4081220	0.0359739	60	0	9.6278519	10.3721481	60
1	9.5921755	9.9639724	0.4078245	0.0360276	59	1	9.6282031	10.3717969	59
2	9.5924728	9.9639187	0.4075272	0.0360813	58	2	9.6285540	10.3714460	58
3	9.5927698	9.9638650	0.4072302	0.0361350	57	3	9.6289048	10.3710952	57
4	9.5930666	9.9638112	0.4069334	0.0361888	56	4	9.6292553	10.3707447	56
5	9.5933631	9.9637574	0.4066369	0.0362426	55	5	9.6296057	10.3703943	55
6	9.5936594	9.9637036	0.4063406	0.0362964	54	6	9.6290558	10.3700442	54
7	9.5939555	9.9636496	0.4060445	0.0363504	53	7	9.6303058	10.3696942	53
8	9.5942513	9.9635957	0.4057487	0.0364043	52	8	9.6306556	10.3693444	52
9	9.5945469	9.9635417	0.4054531	0.0364583	51	9	9.6310052	10.3689948	51
10	9.5948422	9.9634877	0.4051578	0.0365123	50	10	9.6313545	10.3686455	50
11	9.5951373	9.9634336	0.4048627	0.0365664	49	11	9.6317037	10.3682963	49
12	9.5954322	9.9633795	0.4045678	0.0366205	48	12	9.6320527	10.3679473	48
13	9.5957268	9.9633253	0.4042732	0.0366747	47	13	9.6324015	10.3675985	47
14	9.5960212	9.9632711	0.4039788	0.0367289	46	14	9.6327501	10.3672499	46
15	9.5963154	9.9632168	0.4036846	0.0367832	45	15	9.6330985	10.3669015	45
16	9.5966093	9.9631625	0.4033907	0.0368375	44	16	9.6334468	10.3665532	44
17	9.5969030	9.9631082	0.4030970	0.0368918	43	17	9.6337948	10.3662052	43
18	9.5971965	9.9630538	0.4028035	0.0369462	42	18	9.6341426	10.3658574	42
19	9.5974897	9.9629994	0.4025103	0.0370006	41	19	9.6344903	10.3655097	41
20	9.5977827	9.9629449	0.4022173	0.0370551	40	20	9.6348378	10.3651622	40
21	9.5980754	9.9628904	0.4019246	0.0371096	39	21	9.6351850	10.3648150	39
22	9.5983679	9.9628358	0.4016321	0.0371642	38	22	9.6355321	10.3644679	38
23	9.5986602	9.9627812	0.4013398	0.0372188	37	23	9.6358790	10.3641210	37
24	9.5989523	9.9627266	0.4010477	0.0372734	36	24	9.6362257	10.3637743	36
25	9.5992441	9.9626719	0.4007559	0.0373281	35	25	9.6365722	10.3634278	35
26	9.5995357	9.9626172	0.4004643	0.0373828	34	26	9.6369185	10.3630815	34
27	9.5998270	9.9625624	0.4001730	0.0374376	33	27	9.6372646	10.3627354	33
28	9.6001181	9.9625076	0.3998819	0.0374924	32	28	9.6376106	10.3623894	32
29	9.6004090	9.9624527	0.3995910	0.0375473	31	29	9.6379563	10.3620437	31
30	9.6006997	9.9623978	0.3993003	0.0376022	30	30	9.6383019	10.3616981	30
31	9.6009901	9.9623428	0.3990099	0.0376572	29	31	9.6386473	10.3613527	29
32	9.6012803	9.9622878	0.3987197	0.0377122	28	32	9.6389925	10.3610075	28
33	9.6015703	9.9622328	0.3984297	0.0377672	27	33	9.6393375	10.3606625	27
34	9.6018600	9.9621777	0.3981400	0.0378223	26	34	9.6396823	10.3603177	26
35	9.6021494	9.9621226	0.3978505	0.0378774	25	35	9.6400269	10.3599721	25
36	9.6024388	9.9620974	0.3975612	0.0379326	24	36	9.6403714	10.3596286	24
37	9.6027278	9.9620122	0.3972722	0.0379878	23	37	9.6407156	10.3592844	23
38	9.6030166	9.9619569	0.3969834	0.0380431	22	38	9.6410597	10.3589403	22
39	9.6033052	9.9619016	0.3966948	0.0380984	21	39	9.6414036	10.3585964	21
40	9.6035936	9.9618463	0.3964064	0.0381537	20	40	9.6417473	10.3582527	20
41	9.6038817	9.9617909	0.3961183	0.0382091	19	41	9.6420908	10.3579092	19
42	9.6041696	9.9617355	0.3958304	0.0382645	18	42	9.6424342	10.3575658	18
43	9.6044573	9.9616800	0.3955427	0.0383200	17	43	9.6427773	10.3572227	17
44	9.6047448	9.9616245	0.3952552	0.0383755	16	44	9.6431303	10.3568797	16
45	9.6050320	9.9615689	0.3949680	0.0384311	15	45	9.6434631	10.3565369	15
46	9.6053190	9.9615133	0.3946810	0.0384867	14	46	9.6438057	10.3561943	14
47	9.6056057	9.9614576	0.3943943	0.0385424	13	47	9.6441481	10.3558519	13
48	9.6058923	9.9614020	0.3941077	0.0385980	12	48	9.6444903	10.3555097	12
49	9.6061786	9.9613463	0.3938214	0.0386538	11	49	9.6448324	10.3551676	11
50	9.6064647	9.9612904	0.3935353	0.0387096	10	50	9.6451743	10.3548257	10
51	9.6067506	9.9612346	0.3932494	0.0387654	9	51	9.6455160	10.3544840	9
52	9.6070362	9.9611787	0.3929638	0.0388213	8	52	9.6458575	10.3541425	8
53	9.6073216	9.9611228	0.3926784	0.0388772	7	53	9.6461988	10.3538012	7
54	9.6076068	9.9610668	0.3923932	0.0389332	6	54	9.6465400	10.3534600	6
55	9.6078918	9.9610108	0.3921082	0.0389892	5	55	9.6468810	10.3531190	5
56	9.6081765	9.9609548	0.3918235	0.0390452	4	56	9.6472217	10.3527783	4
57	9.6084611	9.9608987	0.3915389	0.0391013	3	57	9.6475624	10.3524376	3
58	9.6087454	9.9608426	0.3912546	0.0391574	2	58	9.6479028	10.3520972	2
59	9.6090294	9.9607864	0.3909706	0.0392136	1	59	9.6482431	10.3517569	1
60	9.6093133	9.9607302	0.3906867	0.0392698	0	60	9.6485831	10.3514169	0
			Co. Arith.	Sign.				Tangent.	

Degrees 66.

M.	Sign.	Co. Arith.					Tangent.		
0	9.6093133	9.9607302	0.3906867	0.0392698	60	0	9.6485331	10.3514169	60
1	9.6095969	9.9606739	0.3904031	0.0393261	59	1	9.6489230	10.3510770	59
2	9.6098803	9.9606176	0.3901197	0.0393824	58	2	9.6492628	10.3507372	58
3	9.6101635	9.9605612	0.3898365	0.0394388	57	3	9.6496023	10.3503977	57
4	9.6104465	9.9605048	0.3895535	0.0394952	56	4	9.6499417	10.3500583	56
5	9.6107293	9.9604484	0.3892707	0.0395516	55	5	9.6502809	10.3497191	55
6	9.6110118	9.9603919	0.3889882	0.0396081	54	6	9.65 6199	10.3493801	54
7	9.6112941	9.9603354	0.3887059	0.0396646	53	7	9.6509587	10.3490413	53
8	9.6115762	9.9602788	0.3884238	0.0397212	52	8	9.6512974	10.3487026	52
9	9.6118580	9.9602222	0.3881420	0.0397778	51	9	9.6516359	10.3483641	51
10	9.6121397	9.9601655	0.3878603	0.0398345	50	10	9.6519742	10.3480258	50
11	9.6124211	9.9601088	0.3875789	0.0398912	49	11	9.6523123	10.3476877	49
12	9.6127023	9.9600520	0.3872977	0.0399480	48	12	9.6526503	10.3473497	48
13	9.6129833	9.9599952	0.3870167	0.0400048	47	13	9.6529881	10.3470119	47
14	9.6132641	9.9599384	0.3867359	0.0400616	46	14	9.6533257	10.3466743	46
15	9.6135446	9.9598815	0.3864554	0.0401185	45	15	9.6536631	10.3463369	45
16	9.6138250	9.9598246	0.3861750	0.0401754	44	16	9.6540004	10.3459996	44
17	9.6141051	9.9597676	0.3858949	0.0402324	43	17	9.6543375	10.3456625	43
18	9.6143850	9.9597106	0.3856150	0.0402894	42	18	9.6546744	10.3453256	42
19	9.6146647	9.9596535	0.3853353	0.0403465	41	19	9.6550112	10.3449888	41
20	9.6149441	9.9595964	0.3850559	0.0404036	40	20	9.6523477	10.3446523	40
21	9.6152234	9.9595393	0.3847766	0.0404607	39	21	9.6556841	10.3443150	39
22	9.6155024	9.9594821	0.3844976	0.0405179	38	22	9.6560204	10.3439796	38
23	9.6157812	9.9594248	0.3842188	0.0405752	37	23	9.6563564	10.3436436	37
24	9.6160599	9.9593675	0.3839401	0.0406326	36	24	9.6566923	10.3433077	36
25	9.6163382	9.9593102	0.3836618	0.0406898	35	25	9.6570280	10.3429720	35
26	9.6166164	9.9592528	0.3833836	0.0407472	34	26	9.6573636	10.3426364	34
27	9.6168944	9.9591954	0.3831056	0.0408046	33	27	9.6576989	10.3423011	33
28	9.6171721	9.9591380	0.3828279	0.0408620	32	28	9.6580341	10.3419659	32
29	9.6174496	9.9590805	0.3825504	0.0409195	31	29	9.6583692	10.3416308	31
30	9.6177270	9.9590229	0.3822730	0.0409771	30	30	9.6587041	10.3412960	30
31	9.6180041	9.9589653	0.3819959	0.0410347	29	31	9.6590387	10.3409613	29
32	9.6182809	9.9589077	0.3817191	0.0410923	28	32	9.6593733	10.3406267	28
33	9.6185576	9.9588500	0.3814424	0.0411500	27	33	9.6597076	10.3402924	27
34	9.6188341	9.9587923	0.3811659	0.0412077	26	34	9.6600418	10.3399582	26
35	9.6191103	9.9587345	0.3808897	0.0412655	25	35	9.6603758	10.3396242	25
36	9.6193864	9.9586767	0.3806136	0.0413233	24	36	9.6607097	10.3392903	24
37	9.6196622	9.9586188	0.3803378	0.0413812	23	37	9.6610434	10.3389566	23
38	9.6199378	9.9585609	0.3800622	0.0414391	22	38	9.6613769	10.3386231	22
39	9.6202132	9.9585030	0.3797868	0.0414970	21	39	9.6617103	10.3382897	21
40	9.6204884	9.9584450	0.3795116	0.0415550	20	40	9.6620534	10.3379566	20
41	9.6207634	9.9583869	0.3792366	0.0416131	19	41	9.6623765	10.3376235	19
42	9.6210382	9.9583288	0.3789618	0.0416712	18	42	9.6627093	10.3372907	18
43	9.6213127	9.9582707	0.3786873	0.0417293	17	43	9.6630420	10.3369580	17
44	9.6215871	9.9582125	0.3784129	0.0417875	16	44	9.6633745	10.3366255	16
45	9.6218612	9.9581543	0.3781388	0.0418457	15	45	9.6637069	10.3362931	15
46	9.6221351	9.9580961	0.3778649	0.0419039	14	46	9.6640391	10.3359609	14
47	9.6224088	9.9580378	0.3775912	0.0419622	13	47	9.6643711	10.3356289	13
48	9.6226824	9.9579794	0.3773176	0.0420206	12	48	9.6647030	10.3352970	12
49	9.6229557	9.9579210	0.3770443	0.0420790	11	49	9.6650346	10.3349654	11
50	9.6232287	9.9578626	0.3767713	0.0421374	10	50	9.6653662	10.3346338	10
51	9.6235016	9.9578041	0.3764984	0.0421959	9	51	9.6656975	10.3343025	9
52	9.6237743	9.9577456	0.3762257	0.0422544	8	52	9.6660288	10.3339712	8
53	9.6240468	9.9576870	0.3759532	0.0423130	7	53	9.6663598	10.3336402	7
54	9.6243190	9.9576284	0.3759810	0.0423716	6	54	9.6666907	10.3333093	6
55	9.6245911	9.9575697	0.3754089	0.0424303	5	55	9.6670214	10.3329786	5
56	9.6248629	9.9575110	0.3751371	0.0424890	4	56	9.6673519	10.3326481	4
57	9.6251346	9.9574522	0.3748654	0.0425478	3	57	9.6676823	10.3323177	3
58	9.6254060	9.9573934	0.3745940	0.0426065	2	58	9.6680126	10.3319874	2
59	9.6256772	9.9573346	0.3743228	0.0426654	1	59	9.6683426	10.3316574	1
60	9.6259483	9.9572757	0.3740517	0.0427243	0	60	9.6686725	10.3313275	0
			Co. Arith.	Sign.				Tangent.	

D	Sign.	Co. Arith.	Tangent.						
0	9.6259483	9.9572757	0.3740517	0.0427243	60	0	9.6686725	10.3313275	60
1	9.6262191	9.9 72168	0.3737809	0.0427832	59	1	9.6690023	10.3309977	59
2	9.6264897	9.9571578	0.3735103	0.0428422	58	2	9.6693319	10 3306681	58
3	9.6267601	9.9570983	0.3732399	0.0429012	57	3	9.6696613	10.3303387	57
4	9.6270303	9.9570397	0.3729697	0.0429603	56	4	9.6699906	10.3300094	56
5	9.6273003	9.9569805	0.3726997	0.0430194	55	5	9.6703197	10.3296803	55
6	9.6275701	9.9569215	0.3724299	0.0430785	54	6	9.6706485	10.3293514	54
7	9.6278397	9.9568623	0.3721603	0.0431377	53	7	9.6709774	1.03290226	53
8	9.6281090	9.9568030	0.3718910	0.0431970	52	8	9.6713050	10.3286940	52
9	9.6283782	9.9567437	0.3716218	0.0432563	51	9	9.6716345	10.3283655	51
10	9.6286472	9.9566844	0.3713528	0.0433156	50	10	9.6719628	10.3280372	50
11	9.6289160	9.9566250	0.3710840	0.0433750	49	11	9.6722910	10.3277090	49
12	9.6291845	9.9565655	0.3708155	0.0434344	48	12	9.6726190	10.3273810	48
13	9.6294529	9.9565061	0.3705471	0.0434939	47	13	9.6729468	10.3270532	47
14	9.6297211	9.9564466	0.3702789	0.0435534	46	14	9.6732745	10.3267255	46
15	9.6299890	9.9563870	0.3700110	0.0436130	45	15	9.6736020	10.3263980	45
16	9.6302568	9.9563274	0.3697432	0.0436726	44	16	9.6739294	10.3260706	44
17	9.6305243	9.9562678	0.3694757	0.0437322	43	17	9.6742566	10.3257434	43
18	9.6307917	9.9562081	0.3692083	0.0437919	42	18	9.6745836	10.3254164	42
19	9.6310589	9.9561483	0.3689411	0.0438517	41	19	9.6749105	10.3250895	41
20	9.6313258	9.9560886	0.3686742	0.0439114	40	20	9.6752372	10.3247628	40
21	9.6315926	9.9560237	0.3684074	0.0439713	39	21	9.6755638	10.3244362	39
22	9.6318591	9.9559689	0.3681409	0.0440311	38	22	9.6758903	10.3241097	38
23	9.6321255	9.9559089	0.3678745	0.0440911	37	23	9.6762165	10.3237835	37
24	9.6323916	9.9558490	0.3676084	0.0441510	36	24	9.6765426	10.3234574	36
25	9.6326576	9.9557890	0.3673424	0.0442110	35	25	9.6768686	10.3231314	35
26	9.6329233	9.9557289	0.3670767	0.0442711	34	26	9.6771944	10.3228056	34
27	9.6331889	9.9556688	0.3668111	0.0443312	33	27	9.6775201	10.3224799	33
28	9.6334542	9.9556087	0.3665458	0.0443913	32	28	9.6778456	10.3221544	32
29	9.6337194	9.9555485	0.3662806	0.0444515	31	29	9.6781709	10.3218291	31
30	9.6339844	9.9554882	0.3660156	0.0445118	30	30	9.6784961	10.3215039	30
31	9.6342491	9.9554280	0.3657509	0.0445720	29	31	9.6788211	10.3211789	29
32	9.6345137	9.9553676	0.3654863	0.0446324	28	32	9.6791460	10.3208540	28
33	9.6347780	9.9553073	0.3652220	0.0446927	27	33	9.6794708	10.3205292	27
34	9.6350422	9.9552469	0.3649578	0.0447531	26	34	9.6797953	10.3202047	26
35	9.6353062	9.9551864	0.3646938	0.0448136	25	35	9.6801198	10.3198802	25
36	9.6355699	9.9551259	0.3644301	0.0448741	24	36	9.6804440	10.3195560	24
37	9.6358335	9.9550653	0.3641665	0.0449347	23	37	9.6807682	10.3192318	23
38	9.6360969	9.9550047	0.3639031	0.0449953	22	38	9.6810921	10.3189079	22
39	9.6363601	9.9549441	0.3636399	0.0450559	21	39	9.6814160	10.3185840	21
40	9.6366231	9.9548834	0.3633769	0.0451166	20	40	9.6817396	10.3182604	20
41	9.6368859	9.9548227	0.3631141	0.0451773	19	41	9.6820632	10.3179368	19
42	9.6371484	9.9547619	0.3628516	0.0452381	18	42	9.6823865	10.3176135	18
43	9.6374108	9.9547011	0.3625892	0.0452989	17	43	9.6827098	10.3172902	17
44	9.6376713	9.9546402	0.3623269	0.0453598	16	44	9.6830328	10.3169672	16
45	9.6379351	9.9545793	0.3620649	0.0454207	15	45	9.6833557	10.3166433	15
46	9.6381969	9.9545184	0.3618032	0.0454816	14	46	9.6836785	10.3163215	14
47	9.6384585	9.9544574	0.3615415	0.0455426	13	47	9.6840011	10.3159989	13
48	9.6387199	9.9543963	0.3612801	0.0456037	12	48	9.6843236	10.3156764	12
49	9.6389812	9.9543352	0.3610188	0.0456648	11	49	9.6846459	10.3153541	11
50	9.6392422	9.9542741	0.3607578	0.0457259	10	50	9.6849681	10.3150319	10
51	9.6395030	9.9542129	0.3604970	0.0457871	9	51	9.6852901	10.3147099	9
52	9.6397637	9.9541517	0.3602363	0.0458483	8	52	9.6856120	10.3143880	8
53	9.6400241	9.9540904	0.3599759	0.0459096	7	53	9.6859338	10.3140662	7
54	9.6402844	9.9540291	0.3597156	0.0459709	6	54	9.6862553	10.3137447	6
55	9.6405445	9.9539677	0.3594555	0.0460323	5	55	9.6865768	10.3134232	5
56	9.6408044	9.9539063	0.3591956	0.0460937	4	56	9.6068981	10.3131019	4
57	9.6410640	9.9538448	0.3589360	0.0461552	3	57	9.6872192	10.3127808	3
58	9.6413235	9.9537833	0.3586765	0.0462167	2	58	9.6875402	10.3124598	2
59	9.6415828	9.9537218	0.3584172	0.0462782	1	59	9.6878611	10.3121389	1
60	9.6418420	9.9536602	0.3581580	0.0463398	0	60	9.6881818	10.3118182	0
			Co.Arith.	Sign.				Tangent.	

D.	Sign.	Co. Arith.	Tangent.						
0	9.6418420	9.9536602	0.3581580	0.0463398	60	0	9.6881818	10.3118182	60
1	9.6421009	9.9535985	0.3578991	0.0464015	59	1	9.6885023	10.3114977	59
2	9.6423596	9.9535369	0.3576404	0.0464631	58	2	9.6888227	10.3111773	58
3	9.6426182	9.9534711	0.3572818	0.0465249	57	3	9.6891430	10.3108570	57
4	9.6428765	9.9534134	0.3571235	0.0465866	56	4	9.6894631	10.3105369	56
5	9.6431347	9.9533513	0.3568653	0.0466485	55	5	9.6897831	10.3102169	55
6	9.6433926	9.9532897	0.3566074	0.0467103	54	6	9.6901030	10.3098970	54
7	9.6436504	9.9532278	0.3563496	0.0467722	53	7	9.6904226	1.03095774	53
8	9.6439080	9.9531658	0.3560920	0.0468342	52	8	9.6907422	10.3092593	52
9	9.6441654	9.9531038	0.3558346	0.0468962	51	9	9.6910616	10.3089384	51
10	9.6444226	9.9530418	0.3555774	0.0469582	50	10	9.6913809	10.3086191	50
11	9.6446796	9.9529797	0.3553204	0.0470203	49	11	9.6917000	10.3083000	49
12	9.6449365	9.9529175	0.3550635	0.0470825	48	12	9.6920189	10.3079811	48
13	9.6451931	9.9528553	0.3548069	0.0471447	47	13	9.6923378	10.3076622	47
14	9.6454496	9.9527931	0.3545504	0.0472069	46	14	9.6926565	10.3073435	46
15	9.6457058	9.9527308	0.3542942	0.0472692	45	15	9.6929750	10.3070250	45
16	9.6459619	9.9526685	0.3540381	0.0473315	44	16	9.6932934	10.3067066	44
17	9.6462178	9.9526061	0.3537822	0.0473939	43	17	9.6936117	10.3063883	43
18	9.6464735	9.9525437	0.3535265	0.0474563	42	18	9.6939298	10.3060782	42
19	9.6467290	9.9524813	0.3532710	0.0475187	41	19	9.6942478	10.3057522	41
20	9.6469844	9.9524188	0.3530156	0.0475812	40	20	9.6945656	10.3054344	40
21	9.6472395	9.9523562	0.3527605	0.0476438	39	21	9.6948833	10.3051167	39
22	9.6474945	9.9522936	0.3525505	0.0477064	38	22	9.6952009	10.3047991	38
23	9.6477492	9.9522310	0.3522508	0.0477690	37	23	9.6955183	10.3044817	37
24	9.6480038	9.9521683	0.3519962	0.0478317	36	24	9.6958355	10.3041645	36
25	9.6482582	9.9521055	0.3517418	0.0478945	35	25	9.6961527	10.3038473	35
26	9.6485124	9.9520428	0.3514876	0.0479572	34	26	9.6964697	10.3035303	34
27	9.6487665	9.9519799	0.3512335	0.0480201	33	27	9.6967865	10.3032135	33
28	9.6490203	9.9519171	0.3509797	0.0480829	32	28	9.6971032	10.3028968	32
29	9.6492740	9.9518541	0.3507260	0.0481459	31	29	9.6974198	10.3025802	31
30	9.6495274	9.9517912	0.3504726	0.0482088	30	30	9.6977363	10.3022637	30
31	9.6497807	9.9517282	0.3502193	0.0482718	29	31	9.6980526	10.3019474	29
32	9.6500338	9.9516651	0.3499662	0.0483349	28	32	9.6983687	10.3016313	28
33	9.6502868	9.9516020	0.3497132	0.0483980	27	33	9.6986847	10.3013153	27
34	9.6505395	9.9515389	0.3494605	0.0484611	26	34	9.6990006	10.3009994	26
35	9.6507920	9.9514757	0.3492080	0.0485243	25	35	9.6993164	10.3006838	25
36	9.6510444	9.9514124	0.3489556	0.0485876	24	36	9.6996320	10.3003680	24
37	9.6512966	9.9513492	0.3487034	0.0486508	23	37	9.6999474	10.3000526	23
38	9.6515486	9.9512858	0.3484514	0.0487142	22	38	9.7002628	10.2997372	22
39	9.6518004	9.9512224	0.3481996	0.0487776	21	39	9.7005780	10.2994220	2
40	9.6520521	9.9511590	0.3479479	0.0488410	20	40	9.7008930	10.2991070	20
41	9.6523035	9.9510956	0.3476960	0.0489044	19	41	9.7012080	10.2987920	19
42	9.6525548	9.9510320	0.3474452	0.0489680	18	42	9.7015227	10.2984773	18
43	9.6528059	9.9509685	0.3471941	0.0490315	17	43	9.7018374	10.2981626	17
44	9.6530568	9.9509049	0.3469432	0.0490951	16	44	9.7021519	10.2978481	16
45	9.6533075	9.9508412	0.3466925	0.0491588	15	45	9.7024663	10.2975337	15
46	9.6535581	9.9507775	0.3464419	0.0492225	14	46	9.7027805	10.2972195	14
47	9.6538084	9.9507138	0.3461916	0.0492862	13	47	9.7030946	10.2969054	13
48	9.6540586	9.9506500	0.3459414	0.0492500	12	48	9.7034086	10.2965914	12
49	9.6543086	9.9505861	0.3456914	0.0494139	11	49	9.7037225	10.2962775	11
50	9.6545584	9.9505223	0.3454416	0.0494777	10	50	9.7040362	10.2959638	10
51	9.6548081	9.9504583	0.3451919	0.0495417	9	51	9.7043497	10.2956503	9
52	9.6550575	9.9503944	0.3449425	0.0496056	8	52	9.7046632	10.2953368	8
53	9.6553086	9.9503303	0.3446932	0.0496697	7	53	9.7049765	10.2950235	7
54	9.6555559	9.9502663	0.3444441	0.0497337	6	54	9.7052897	10.2947103	6
55	9.6558048	9.9502022	0.3441952	0.0497978	5	55	9.7056027	10.2943973	5
56	9.6560536	9.9501380	0.3439464	0.0498620	4	56	9.7059156	10.2940844	4
57	9.6563021	9.9500738	0.3436979	0.0499262	3	57	9.7062284	10.2937716	3
58	9.6565505	9.9500095	0.3434495	0.0499905	2	58	9.7065110	10.2934590	2
59	9.6567987	9.9599452	0.3432813	0.0500548	1	59	9.7068535	10.2931465	1
60	9.6570468	9.9598809	0.3439532	0.0501191	0	60	9.7071659	10.2928341	0
			Co.Arith.	Sign.				Tangent.	

D.	Sign.	Co.Arith.					Tangent.		
0	9.6570468	9.9493809	0.3429532	0.0501191	60	0	9.7071659	10.2928341	60
1	9.6572946	9.9498165	0.3427054	0.0501835	59	1	9.7074781	10.2925219	59
2	9.6575423	9.9497521	0.3424577	0.0502479	58	2	9.7077902	10.2922098	58
3	9.6577898	9.9496876	0.3422102	0.0503124	57	3	9.7081022	10.2918978	57
4	9.6580378	9.9496230	0.3419629	0.0503770	56	4	9.7084141	10.2915859	56
5	9.6582842	9.9495585	0.3417158	0.0504415	55	5	9.7087258	10.2912742	55
6	9.6535312	9.9494938	0.3414683	0.0505062	54	6	9.7090374	10.2909626	54
7	9.6587780	9.9494292	0.3412220	0.0505708	53	7	9.7093488	10.2906512	53
8	9.6590246	9.9493645	0.3409754	0.0506355	52	8	9.7096601	10.2903399	52
9	9.6592710	9.9492997	0.3407290	0.0507003	51	9	9.7099713	10.2900287	51
10	9.5595173	9.9492349	0.3404827	0.0507611	50	10	9.7002824	10.2897176	50
11	9.6597634	9.9491700	0.3402367	0.0508300	49	11	9.7105933	10.2994067	49
12	9.6600093	9.9491051	0.3399907	0.0508949	48	12	9.7109041	10.2890959	48
13	9.6602550	9.9490402	0.3397450	0.0509598	47	13	9.7112148	10 2887852	47
14	9.6605005	9.9489752	0.3394995	0.0500248	46	14	9.7115253	10.2884746	46
15	9.6607459	9.0489101	0.3392541	0.0500899	45	15	9.7118358	10.2881642	45
16	9.6609911	9.9488450	0.3390089	0.0511550	44	16	9.7121461	10.2878539	44
17	9.6612361	9.9487799	0.3387639	0.0512201	43	17	9.7124562	10.2875438	43
18	9.6614810	9.9487147	0.3385190	0.0512853	42	18	9.7127662	10.2872338	42
19	9.6617257	9.9486495	0.3382743	00.513505	41	19	9.7130761	10.2869239	41
20	9.6619702	9.9485842	0.3380298	0.0514158	40	20	9.7133859	10.2866141	40
21	9.6622145	9.9485189	0.3377855	0.0514811	39	21	9.7136956	10.2863044	39
22	9.6624586	9.9484535	0.3375414	0.0515465	38	22	9.7140051	10.2859949	38
23	9.6627026	9.9483881	0.3372974	0.0516119	37	23	9.7143145	10.2856855	37
24	9.6629464	9.9483227	0.3370536	0.0516773	36	24	9.7146237	10.2853763	36
25	9.6631900	9.9482572	0.3368100	0.0517428	35	25	9.7149329	10.2850671	35
26	9.6634335	9.9481916	0.3365665	0.0518084	34	26	9.7152419	10.2847581	34
27	9.6636768	9.9481260	0.3363232	0.0518740	33	27	9.7155508	10.2844492	33
28	9.6639199	9.9480604	0.3360801	0.0519396	32	28	9.7158595	10.2841405	32
29	9.6641628	9.9479947	0.3358372	0.0520053	31	29	9.7161682	10.2838318	31
30	9.6644056	9.9479289	0.3355944	0.0520711	30	30	9.7164767	10.2835233	30
31	9.6646482	9.9478631	0.3353518	0.0521369	29	31	9.7167851	10.2832149	29
32	9.6648906	9.9477973	0.3351094	0.0522027	28	32	9.7170933	10.2829067	28
33	9.6651329	9.9477314	0.3348671	0.0522686	27	33	9.7174014	10.2825986	27
34	9.6653749	9.9476655	0.3346251	0.0523345	26	34	9.7177094	10.2822906	26
35	9.6656168	9.9475995	0.3343822	0.0524005	25	35	9.7180173	10.2819827	25
36	9.6658586	9.9475335	0.3341414	0.0524665	24	36	9.7183251	10.2816749	24
37	9.6661001	9.9474674	0.3338999	0.0525326	23	37	9.7186327	10.2813673	23
38	9.6663415	9.9474013	0.3336585	0.0525987	22	38	9.7189402	10.2810598	22
39	9.6665828	9.9473352	0.3334172	0.0526648	21	39	9.7192476	10.2807524	21
40	9.6668238	9.9472689	0.3331762	0,0527311	20	40	9.7195549	10.2804451	20
41	9.6670647	9.9472027	0.3329353	0.0527973	19	41	9.7198620	10.2801380	19
42	9.6673054	9.9471364	0.3325946	0.0528636	18	42	9.7201690	10.2798309	18
43	9.6675459	9.9470700	0. 324541	0.0529300	17	43	9.7204759	10.2795241	17
44	9.6677863	9.9470036	0.3322137	0.0529964	16	44	9.7207827	10.2792173	16
45	9.6680265	9.9469372	0.3319735	0.0530628	15	45	9.7210893	10.2789107	15
46	9.6682665	9.9468707	0.3317335	0.0531293	14	46	9.7213958	10.2786042	14
47	9.6685064	9.9468042	0.3314936	0.0531958	13	47	9.7217022	10.2782978	13
48	9.6687461	9.9467376	0.3312539	0.0532624	12	48	9.7220085	10.2779915	12
49	9.6689856	9.9466710	0.3310144	0.0533290	11	49	9.7223147	10.2776853	11
50	9.6692250	9.9466043	0.3307850	0.9533957	10	50	9.7226207	10.2773793	10
51	9.6694642	9.9465336	0.3305358	0.0534624	9	51	9.7229266	10.2770734	9
52	9.6697032	9.9464708	0.3302968	0.0535292	8	52	9.7232324	10.2767676	8
53	9.6699420	9.9464040	0.3300580	0.0535960	7	53	9.7235381	10.2764619	7
54	9.6701807	9.9463371	0.3298193	0.0536629	6	54	9.7238436	10.2761564	6
55	9.6704192	9.9462702	0.3295808	0.0537298	5	55	9.7241490	10.2758510	5
56	9.6706576	9.9462032	0.3293424	0.0537968	4	56	9.7244543	10.2755457	4
57	9.6708958	9.9461362	0.3291042	0.0538638	3	57	9.7247595	10.2752405	3
58	9.6711338	9.9460692	0.3288662	0.0539308	2	58	9.7250646	10.2749354	2
59	9.6713716	9.9460021	0.3286284	0.0539979	1	59	9.7253695	10.2746305	1
60	9.6716093	9.9469349	0.3283907	0.0530651	0	60	9.7256744	10.2743256	0
			Co.Arith.	Sign.				Tangent.	

D.	Sign.	Co.Arith.					Tangent.		
0	9.6716093	9.9459349	0.3283907	0.0540651	60	0	9.7256744	10.2743256	60
1	9.6718468	9.9458677	0.3281532	0.0541323	59	1	9.7259791	10.2740209	50
2	9.6720841	9.9458005	0.3279159	0.0541995	58	2	9.7262837	10.2737163	59
3	9.6723213	9.7457332	0.3276787	0.0542668	57	3	9.7265881	10.2734119	58
4	9.6725583	9.9456659	0.3274417	0.0543341	56	4	9.7268925	10.2731075	57
5	9.6727952	9.9455985	0.3272048	0.0544014	55	5	9.7271967	10.2728033	56
6	9.6730319	9.9455310	0.3269681	0.0544690	54	6	9.7275008	10.2724992	56
7	9.6732684	9.9454636	0.3267316	0.0545364	53	7	9.7278048	10.2721952	54
8	9.6735047	9.9453960	0.3264953	0.0546040	52	8	9.7281087	10.2718913	53
9	9.6737409	9.9453285	0.3262691	0.0546715	51	9	9.7284124	10.2715876	52
10	9.6739769	9.9452609	0.3260231	0.0547391	50	10	9.7287161	10.2712829	51
11	9.6742128	9.9451932	0.3257872	0.0548068	49	11	9.7290196	10.2709804	49
12	9.6744485	9.9451255	0.3255515	0.0548745	48	12	9.7293230	10.2706770	48
13	9.6746840	9.9450577	0.3253160	0.0549423	47	13	9.7296263	10 2703737	47
14	9.6749194	9.9449899	0.3250806	0.0550101	46	14	9.7299275	10.2700705	46
15	9.6751546	9.0449220	0.3248454	0.0550780	45	15	9.7302325	10.2797675	45
16	9.6753896	9.9448541	0.3246104	0.0551459	44	16	9.7305354	10.2694646	44
17	9.6356245	9.9447862	0 3243756	0.0552138	43	17	9.7308383	10.2661617	43
18	9.6758592	9.9447182	0.3241408	0.0552818	42	18	9.7311410	10.2688590	42
19	9.6760937	9.9446501	0.3239063	0.0553499	41	19	9.7314436	10.2585564	41
20	9.6763281	9.9445821	0.3236719	0.0554179	40	20	9.7317460	10.2682540	40
21	9.6765623	9.9445139	0.3234377	0.0554861	39	21	9.7320484	10.2679516	39
22	9.6767963	9.9444457	0.3232037	0.0555543	38	22	9.7323506	10.2676494	38
23	9.6770302	9.9443775	0.3229698	0.0556225	37	23	9.7326527	10.2673473	37
24	9.6772640	9.9443092	0.3227360	0.0556908	36	24	9.7329547	10.2670453	37
25	9.6774975	9.9442409	0.3225025	0.0557591	35	25	9.7322566	10.2664434	35
26	9.6777309	9.9441725	0.3222691	0.0558275	34	26	9.7335584	10.2664416	34
27	9.6779642	9.9441041	0.3220358	0.0558955	33	27	9.7338601	10.2661399	33
28	9.6781972	9.9440356	0.3218028	0.0559644	32	28	9.7341616	10.2658384	32
29	9.6784301	9.9439671	0.3215699	0.0560329	31	29	9.7344631	10.2655369	31
30	9.6786629	9.9438958	0.3213371	0.0561015	30	30	9.7347644	10.2652356	30
31	9.6788955	9.9438289	0.3211045	0.0561701	29	31	9.7350656	10.2649344	29
32	9.6791279	9.9437612	0.3218721	0.0562388	28	32	9.7353667	10.2646333	28
33	9.6793602	9.9436925	0.3206398	0.0563075	27	33	9.7356677	10.2643323	27
34	9.6795923	9.9436238	0.3204077	0.0563762	26	34	9.7359685	10.2640315	26
35	9.6798243	9.9435549	0.3201757	0.0564451	25	35	9.7362693	10.2637307	25
36	9.6800560	9.9434861	0.3199440	0.0565139	24	36	9.7365699	10.2634301	24
37	9.6802877	9.9434172	0.3197123	0.0565828	23	37	9.7368705	10.2631295	23
38	9.6805191	9.9433482	0.3194809	0.0566518	22	38	9.7371309	10.2628291	22
39	9.6807504	9.9432792	0.3192496	0.0567208	21	39	9.7364712	10.2625288	21
40	9.6809816	9.9432102	0.3190184	0.0567898	20	40	9.7377714	10.2622286	20
41	9.6612126	9.9431411	0.3187874	0.0568589	19	41	9.7380715	10.2619285	19
42	9.6814434	9.9430720	0.3185566	0.0569280	18	42	9.7383714	10.2616286	18
43	9.6816741	9.9430028	0.3183259	0.0569972	17	43	9.7386713	10.2613287	17
44	9.6819046	9.9429335	0.3180954	0.0570665	16	44	9.7389710	10.2610290	16
45	9.6821349	9.9428643	0.3178651	0.0571357	15	45	9.7392707	10.2607293	15
46	9.6823651	9.9427949	0.3176349	0.0572051	14	46	9.7395702	10.2604298	14
47	9.6825952	9.9427255	0.3174048	0.0572745	13	47	9.7398696	10.2601304	13
48	9.6828250	9.9426561	0.3171750	0.0573439	12	48	9.7401689	10.2598311	12
49	9.6830548	9.9425866	0.3169452	0.0574134	11	49	9.7404681	10.2595319	11
50	9.6832843	9.9425171	0.3167157	0.9574829	10	50	9.7407672	10.2592328	10
51	9.6835137	9.9424476	0.3164863	0.0575524	9	51	9.7410662	10.2589338	9
52	9.6837430	9.9423779	0.3162570	0.0576221	8	52	9.7413650	10.2586350	8
53	9.6839720	9.9423083	0.3160280	0.0576917	7	53	9.7416638	10.2583362	7
54	9.6842012	9.9422386	0.3157990	0.0577614	6	54	9.7419624	10.2580376	6
55	9.6844297	9.9421688	0.2155703	0.0578312	5	55	9.7422609	10.2577391	5
56	9.6846583	9.9420990	0.3153417	0.0579010	4	59	9.7425594	10.2574406	4
57	9.6848868	9.9420291	0.3151132	0.0579709	3	47	9.7428577	10.2571423	3
58	9.6851151	9.9419592	0.3148849	0.0580408	2	58	9.7431559	10.2568441	2
59	9.6853432	9.9418893	0.3146568	0.0581107	1	59	9.7434540	10.2565460	1
60	9.6855712	9.9418193	0.3144288	0.0581807	0	60	9.7437520	10.2562580	0
			Co.Arith.	Sign.				Tangent.	

Degrees 28.

D.	Sign.	Co. Arith.					Tangent.		
0	9.6855712	9.9418193	0.3144288	0.0581807	60	0	9.7437520	10.2562480	60
1	9.6857991	9.9417492	0.3142009	0.0582508	59	1	9.7440499	10.2559501	59
2	9.6860267	9.9416791	0.3139733	0.0583209	58	2	9.7443476	10.2556524	58
3	9.6862542	9.9416090	0.3137458	0.0583910	57	3	9.7446453	10.2553547	57
4	9.6864816	9.9415388	0.3135184	0.0584612	56	4	9.7449428	10.2550572	56
5	9.6867088	9.9414685	0.3132912	0.0585315	55	5	9.7452403	10.2547597	55
6	9.6869359	9.9413982	0.3130641	0.0586018	54	6	9.7455376	10.2544624	54
7	9.6871628	9.9413279	0.3128372	0.0586721	53	7	9.7458349	10.2541651	53
8	9.6873895	9.9412575	0.3126105	0.0587425	52	8	9.7461320	10.2538680	52
9	9.6876161	9.9411871	0.3123839	0.0588129	51	9	9.7464290	10.2535710	51
10	9.6878425	9.9411166	0.3121575	0.0588834	50	10	9.7467259	10.2532741	50
11	9.6880683	9.9410461	0.3119312	0.0589539	49	11	9.7470227	10.2529773	49
12	9.6882949	9.9409755	0.3117051	0.0590245	48	12	9.7473194	10.2526807	48
13	9.6885209	9.9409048	0.3114791	0.0590952	47	13	9.7476160	10.2523840	47
14	9.6887467	9.9408342	0.3112533	0.0591658	46	14	9.7479125	10.2520875	46
15	9.6889723	9.0407634	0.3110277	0.0592366	45	15	9.7482089	10.2517911	45
16	9.6891978	9.9406927	0.3108022	0.0593073	44	16	9.7485052	10.2514948	44
17	9.6894232	9.9406219	0.3105768	0.0595781	43	17	9.7488013	10.2511987	43
18	9.6896484	9.9405510	0.3103516	0.0594490	42	18	9.7490974	10.2509026	42
19	9.6898724	9.9404801	0.3101266	0.0595199	41	19	9.7493934	10.2506066	41
20	9.6900983	9.9404091	0.3099017	0.0595909	40	20	9.7496892	10.2503108	40
21	9.6903231	9.9403381	0.3096769	0.0596619	39	21	9.7499850	10.2500150	39
22	9.6905476	9.9402670	0.3094524	0.0597330	38	22	9.7502806	10.2497194	38
23	9.6907721	9.9401959	0.3092279	0.0598041	37	23	9.7505762	10.2494238	37
24	9.6909964	9.9401248	0.3090036	0.0598752	36	24	9.7508716	10.2491284	36
25	9.6912205	9.9400535	0.3087795	0.0599465	35	25	9.7511669	10.2488331	35
26	9.6914445	9.9399823	0.3085555	0.0600177	34	26	9.7514622	10.2485378	34
27	9.6916683	9.9399110	0.3083317	0.0600890	33	27	9.7517573	10.2482427	33
28	9.6918919	9.9398396	0.3081081	0.0601604	32	28	9.7520523	10.2479477	32
29	9.6921155	9.9397682	0.3078845	0.0602318	31	29	9.7523472	10.2476528	31
30	9.6923388	9.9396968	0.3076612	0.0603032	30	30	9.7526420	10.2473580	30
31	9.6925620	9.9396253	0.3074380	0.0603747	29	31	9.7529368	10.2470632	29
32	9.6927851	9.9395537	0.3072149	0.0604463	28	32	9.7532314	10.2467686	28
3	9.6930080	9.9394821	0.3069920	0.0605179	27	33	9.7535259	10.2461741	27
34	9.6932308	9.9394105	0.3067692	0.0605895	26	34	9.7538203	10.2469797	26
35	9.6934534	9.9393388	6.3065466	0.0606612	25	35	9.7541136	10.2458854	25
36	9.6936758	9.9392671	0.3063242	0.0607329	24	36	9.7544088	10.2455912	24
37	9.6938981	9.9391953	0.3061019	0.0608047	23	37	9.7547029	10.2452971	23
38	9.6941203	9.9391234	0.3058797	0.0608766	22	38	9.7549969	10.2450031	22
39	9.6943423	9.9390515	0.3056577	0.0609485	21	39	9.7552908	10.2447092	21
40	9.6945642	9.9399796	0.3054358	0.0610204	20	40	9.7555846	10.2444154	20
41	9.6947859	9.9389076	0.3052141	0.0010924	19	41	9.7558783	10.2441217	19
42	9.6950071	9.9388356	0.3049926	0.0611644	18	42	9.7561718	10.2438282	18
43	9.6952288	9.9387635	0.3047712	0.0612365	17	43	9.7564653	10.2435347	17
44	9.6954501	9.9386914	0.3045499	0.0613086	16	44	9.7567587	10.2432413	16
45	9.6956712	9.9386192	0.3043288	0.0613808	15	45	9.7570520	10.2429480	15
46	9.6958922	9.9385470	0.3041078	0.0614530	14	46	9.7573452	10.2426548	14
47	9.6961130	9.9384747	0.3038870	0.0615252	13	47	9.7576383	10.2423617	13
48	9.6963336	9.9384024	0.3036664	0.0615976	12	48	9.7579313	10.2420687	12
49	9.6965541	9.9383300	0.3034456	0.0616700	11	49	9.7582242	10.2417758	11
50	9.6967745	9.9382576	0.3032255	0.0617424	10	50	9.7585170	10.2414837	10
51	9.6969947	9.9381851	0.3030053	0.0618149	9	51	9.7588096	10.2411904	9
52	9.6972148	9.9381126	0.3027852	0.0618874	8	52	9.7591022	10.2408978	8
53	9.6974347	9.9380400	0.3025653	0.0619600	7	53	9.7593947	10.2406053	7
54	9.6976545	9.9379674	0.3023455	0.0620326	6	54	9.7596871	10.2403129	6
55	9.6978741	9.9378947	0.3021250	0.0621053	5	55	9.7599794	10.2400206	5
56	9.6980936	9.9378220	0.3019064	0.0621780	4	56	9.7602716	10.2397284	4
57	9.6983129	9.9377492	0.3016871	0.0622508	3	57	9.7605637	1.02394363	3
58	9.6985321	9.9376764	0.3014679	0.0623236	2	58	9.7608557	10.2391443	2
59	9.6987511	9.9376035	0.3012489	0.0623965	1	59	9.7611476	10.2388524	1
60	9.6989700	9.9375306	0.3010300	0.0624694	0	60	9.7614394	10.2385606	0
			Co.Arith.	Sign.				Tangent.	

Degrees 62.

D.	Sign.	Co. Arith.					Tangent.		
0	9.6989700	9.9375306	0.3010300	0.0624694	60	0	9.7614394	10.2385606	60
1	9.6991887	9.9374577	0.3008113	0.0625423	59	1	9.7617311	10.2382689	59
2	9.6994073	9.9373847	0.3005927	0.0626153	58	2	9.7620227	10.2379773	58
3	9.6996258	9.9373116	0.3003742	0.0629881	57	3	9.7623142	10.2376858	57
4	9.6998441	9.9372385	0.3001559	0.0627615	56	4	9.7626056	10.2373944	56
5	9.7000622	9.9371653	0.3009378	0.0628347	55	5	6.7628969	10.2371031	55
6	9.7002802	9.9370921	0.2997198	0.0629079	54	6	9.7631881	10.2368119	54
7	9.7004981	9.9370189	0.2995019	0.0629811	53	7	9.7634792	1.02365208	53
8	9.7007158	9.9369456	0.2992842	0.0630544	52	8	9.7637702	10.2362298	52
9	9.7009334	9.9368722	0.2990666	0.0631278	51	9	9.7640612	10.2359388	51
10	9.7011508	9.9367988	0.2988492	0.0632012	50	10	9.7643520	10.2356480	50
11	9.7013681	9.9367254	0.2986319	0.0632746	49	11	9.7646427	10.2353573	49
12	9.7015852	9.9366519	0.2984148	0.0633481	48	12	9.7649334	10.2350666	48
13	9.7018022	9.9365783	0.2981978	0.0634217	47	13	9.7652239	10.2347761	47
14	9.7020190	9.9365047	0.2979810	0.0634953	46	14	9.7655143	10.2344857	46
15	9.7022357	9.9364311	0.2977643	0.0635689	45	15	9.7658047	10.2341953	45
16	9.7024523	9.9363574	0.2975477	0.0636426	44	16	9.7660949	10.2339051	44
17	9.7026687	9.9362836	0.2973313	0.0637164	43	17	9.7663851	10.2336149	43
18	9.7028849	9.9362098	0.2971151	0.0637902	42	18	9.7666751	10.2333249	42
19	9.7031011	9.9361360	0.2968989	0.0638640	41	19	9.7669651	10.2330349	41
20	9.7033179	9.9360621	0.2966840	0.0639379	40	20	9.7672550	10.2327450	40
21	9.7035329	9.9359881	0.2964671	0.0640119	39	21	9.7675448	10.2324552	39
22	9.7037486	9.9359141	0.2962514	0.0640859	38	22	9.7678344	10.2321656	38
23	9.7039641	9.9358401	0.2960359	0.0641599	37	23	9.7681240	10.2318760	37
24	9.7041795	9.9357660	0.2958205	0.0642340	36	24	9.7684135	10.2315865	36
25	9.7043987	9.9356918	0.2956053	0.0643082	35	25	9.7687029	10.2312971	35
26	9.7046099	9.9356177	0.2953901	0.0643823	34	26	9.7689922	10.2310078	34
27	9.7048248	9.9354431	0.2951752	0.0644066	33	27	9.7692814	10.2307186	33
28	9.7050397	9.9354691	0.2949603	0.0645309	32	28	9.7695705	10.2304295	32
29	9.7052543	9.9353948	0.2947457	0.0646052	31	29	9.7698596	10.2301404	31
30	9.7054689	9.9353204	0.2945311	0.0646796	30	30	9.7701485	10.2298515	30
31	9.7056833	9.9352459	0.2943167	0.0647541	29	31	9.7704373	10.2295627	29
32	9.7058975	9.9351715	0.2941025	0.0648285	28	32	9.7707261	10.2292739	28
33	9.7061116	9.9350969	0.2938884	0.0649031	27	33	9.7710147	10.2289853	27
34	9.7063256	9.9350223	0.2936744	0.0649777	26	34	9.7713033	10.2286967	26
35	9.7065394	9.9349477	0.2934606	0.0650523	25	35	9.7715917	10.2284083	25
36	9.7067531	9.9348730	0.2932469	0.0651270	24	36	9.7718801	10.2281199	24
37	9.7069667	9.9347983	0.2930333	0.0652017	23	37	9.7721684	10.2278316	23
38	9.7071801	9.9347235	0.2928199	0.0652765	22	38	9.7724560	10.2275434	22
39	9.7073933	9.9346486	0.2926067	0.0653514	21	39	9.7727447	10.2272553	21
40	9.7076064	9.9345738	0.2923936	0.0654262	20	40	9.7730327	10.2269673	20
41	9.7078194	9.9344988	0.2921806	0.0655012	19	41	9.7733206	10.2266794	19
42	9.7080323	9.9344238	0.2919677	0.0655762	18	42	9.7736084	10.2263916	18
43	9.7082450	9.9343488	0.2917550	0.0656512	17	43	9.7738961	10.2261039	17
44	9.7084575	9.9342737	0.2915425	0.0657263	16	44	9.7741838	10.2258162	16
45	9.7086699	9.9341986	0.2913301	0.0658014	15	45	9.7744713	10.2255287	15
46	9.7088822	9.9341234	0.2911178	0.0658766	14	46	9.7747588	10.2252412	14
47	9.7090943	9.9340482	0.2909057	0.0659518	13	47	9.7750462	10.2249538	13
48	9.7093063	9.9339729	0.2906937	0.0600271	12	48	9.7753334	10.2246666	12
49	9.7095182	9.9338976	0.2904818	0.0661024	11	49	9.7766206	10.2243794	11
50	9.7097299	9.9338222	0.2902701	0.0661778	10	50	9.7759077	10.2240923	10
51	9.7099415	9.9337467	0.2900585	0.0662533	9	51	9.7761947	10.2238053	9
52	9.7101529	9.9336713	0.2898471	0.0663287	8	52	9.7764816	10.2235184	8
53	9.7103642	9.9335957	0.2896358	0.0664043	7	53	9.7767685	10.2232315	7
54	9.7105753	9.9335201	0.2894247	0.0664799	6	54	9.7770552	10.2229448	6
55	9.7107863	9.9334445	0.2892137	0.0665555	5	55	9.7773418	10.2226582	5
56	9.7109972	9.9333688	0.2890028	0.0666312	4	56	9.7776284	10.2223716	4
57	9.7112080	9.9332931	0.2887920	0.0567069	3	57	9.7779149	10.2220851	3
58	9.7114186	9.9332173	0.2885814	0.0667827	2	58	9.7782012	10.2217988	2
59	9.7116290	9.9331415	0.2883710	0.0668585	1	59	9.7784875	10.2215125	1
60	9.7118393	9.9330656	0.2881607	0.0669341	0	60	9.7787737	10.2212263	0
			Co.Arith.	Sign.				Tangent.	

Degrees 31.

D.	Sign.	Co.Arith.					Tangent.		
0	9.7118323	9.9330656	0.2881607	0.0669344	60	0	9.7787737	10.2212263	60
1	9.7120495	9.9329897	0.2879505	0.0670103	59	1	9.779059[illegible]	10.2209401	59
2	9.7122595	9.9329137	0.2877404	0.0670863	58	2	9.7793459	10.2206541	58
3	9.7124 95	9.9328376	0.2875305	0.0671624	57	3	9.7796318	10.2203682	57
4	9.7120792	9.9327616	0.2873208	0.0672384	56	4	9.7799177	10.2200823	56
5	9.7128889	9.9326854	0.2871111	0.0673146	55	5	9.7808234	10.2197966	55
6	9.7130983	9.9326092	0.2869017	0.0673900	54	6	9.7804891	10.2195109	54
7	9.7133077	9.9325330	0.2866923	0.0674670	53	7	9.7807747	10.2192253	53
8	9.7135 69	9.9324567	0.2864831	0.0675433	52	8	9.7810602	10.2189398	52
9	9.7137260	9.9323804	0.2862740	0.0676196	51	9	9.7813456	10.2186544	51
10	9.7139349	9.9323040	0.2860651	0.0676960	50	10	9.7816309	10.2183691	50
11	9.7141437	9.9322275	0.2858563	0.0677724	49	11	9.7819162	10.2180838	49
12	9.714 524	9.9321511	0.2856476	0.0678489	48	12	9.7822013	10.2177987	48
13	9.7145609	9.9320746	0.2854391	0.0679254	47	13	9.7824864	10.2175136	47
14	9.7147693	9.9319980	0.2852307	0.0680020	46	14	9.7827713	10.2172287	46
15	9.7149776	9.9319213	0.2850224	0.0680787	45	15	9.7830562	10.2169438	45
16	9.7151857	9.9318447	0.2848143	0.0681553	44	16	9.7833410	10.2166590	44
17	9.7153937	9.9317679	0.2846063	0.0682321	43	17	9.7836258	10.2163742	43
18	9.7156015	9.9316911	0.2843985	0.0683089	42	18	9.7839104	10.2160896	42
19	9.7158092	9.9316143	0.2841908	00.683857	41	19	9.7841949	10.2158051	41
20	9.7160168	9.9315374	0.2839832	0.0684626	40	20	9.7844794	10.2155206	40
21	9.7162243	9.9314605	0.2837757	0.0685395	39	21	9.7847638	10.2152362	39
22	9.7164316	9.9313835	0.2835684	0.0686165	38	22	9.9850481	10.2145519	38
23	9.7166387	9.9313065	0.2833613	0.0686935	37	23	9.7853323	10.2146677	37
24	9.7168458	9.9312294	0.2831542	0.0687705	36	24	9.7856164	10.2143836	36
25	9.7170526	9.9311522	0.2829474	0.0688478	35	25	9.7859004	10.2140996	35
26	9.7172594	9.9310750	0.2827406	0.0689250	34	26	9.7861844	10.2138156	34
27	9.7174660	9.9309978	0.2825340	0.0690022	33	27	9.7864682	10.2135318	33
28	9.7176725	9.9309205	0.2823275	0.0690795	32	28	9.7867520	10.2132480	32
29	9.7178789	9.9308432	0.2821211	0.0691568	31	29	9.7870357	10.2129643	31
30	9.7180851	9.9307658	0.2819149	0.0692342	30	30	9.7873193	10.2126807	30
31	9.7182912	9.9306883	0.2817088	0.0693117	29	31	9.7876028	10.2123972	29
32	9.7184971	9.9306109	0.2815029	0.0693892	28	32	9.7878863	10.2121137	28
33	9.7187030	9.9305333	0.2812970	0.0694667	27	33	9.7881696	10.2118304	27
34	9.7189086	9.9304557	0.2810914	0.0695443	26	34	9.7884529	10.2115471	26
35	9.7191142	9.9303781	0.2808858	0.0696219	25	35	9.7887361	10.2112639	25
36	9.7193196	9.9303004	0.2806804	0.0696996	24	36	9.7890192	10.2109808	24
37	9.7195249	9.9302226	0.2804751	0.0697774	23	37	9.7893023	10.2106977	23
38	9.7197300	9.9301448	0.2802700	0.0698552	22	38	9.7895852	10.2104148	22
9	9.7199350	9.9300670	0.2800640	0.0699330	21	39	9.7898681	10.21013 9	21
40	9.7201399	9.9299891	0.2798601	0.0700109	20	40	9.7901508	10.2098492	20
41	9.720 447	9.9299112	0.2796553	0.0700888	19	41	9.7904335	10.2095665	19
42	9.7205493	9.9298332	0.2794507	0.0701668	18	42	9.7907161	10.2092839	18
43	9.7207538	9.9297551	0.2792462	0.07024 9	17	43	9.7909987	10.2090013	17
44	9.7209581	9.9296770	0.2790419	0.0703230	16	44	9.7912811	10.2087189	16
45	9.7211623	9.9295989	0.2788377	0.0704011	15	45	9.7915635	10.2084365	15
46	9.7213664	9.9295207	0.2786336	0.0704793	14	46	9.7918458	10.2081542	14
47	9.7215704	9.9294424	0.2784296	0.0705576	13	47	9.7921280	10.2078720	1
48	9.7217742	9.9293641	0.2782258	0.0706359	12	8	9.7924101	10.2075899	12
49	9.7219779	9.9292857	0.2780221	0.0707143	11	49	9.7926921	102073076	11
50	9.7221814	9.9292073	0.2778186	0.0707927	10	50	9.7929741	10.2070259	10
51	9.72238 8	9.9291289	0.2776152	0.0708711	9	51	9.7932560	10.2067440	9
52	9.7225881	9.9290504	0.2774119	0.0709496	8	52	9.7935378	10.2064622	8
53	9.7227913	9.9289718	0.2772087	0.0710282	7	53	9.7938195	10.2061805	7
54	9.7229943	9.9288932	0.2770057	0.0711068	6	54	9.7941011	10.2058989	6
55	9.7231972	9.9288145	0.2768028	0.0711855	5	55	9.7942827	10.2056173	5
56	9.7234000	9.9287358	0.2756000	0.0712642	4	56	9.7946641	10.2053359	4
57	9.7230026	9.9286571	0.2763974	0.0713429	3	57	9.79494 5	10.2050545	3
58	9.7238051	9.9285783	0.2761949	0.0714217	2	58	9.7952268	10.20477 2	2
59	9.7240075	9.9284994	0.2759925	0.0715003	1	59	9.7955081	10.2044919	1
60	9.7242097	9.9284205	0.2757903	0.0715795	0	60	9.7957892	10.2042108	0
			Co.Arith.	Sign.				Tangent.	

Degrees 58.

D.	Sign.	Co.Arith.					Tangent.		
0	9.7242097	9.9284205	0.2757903	0.0615795	60	0	9.7957892	10.2042103	60
1	9.7244118	9.9283415	0.2755882	0.0716585	59	1	9.7960703	10.2039297	59
2	9.7246138	9.9282625	0.2753862	0.0717375	58	2	9.7963513	10.2036487	58
3	9.7248156	9.9281834	0.2751844	0.0718166	57	3	9.7966322	10.203[illegible]678	57
4	9.7250174	9.9281043	0.2749826	0.0718957	56	4	9.7969130	10.2030870	56
5	9.7252189	9.9280251	0.2747811	0.0719749	55	5	9.7571938	10.2028062	55
6	9.7254204	9.9279459	0.2745796	0.0720541	54	6	9.7974745	10.2025255	54
7	9.7256217	9.9278656	0.2743783	0.0721334	53	7	9.7977551	10.2022449	53
8	9.7258229	9.9277873	0.2741771	0.0722127	52	8	9.7980356	10.2019644	52
9	9.7260240	9.9277079	0.2739760	0.0722921	51	9	9.7983160	10.2016840	51
10	9.7262249	9.9276285	0.2737751	0.0723715	50	10	9.7985964	10.2014036	50
11	9.7264257	9.9275490	0.2735743	0.0724510	40	11	9.7988767	10.2011233	49
12	9.7266264	9.9274695	0.2733736	0.0725305	48	12	9.7991569	10.2008431	48
13	9.7268269	9.9273899	0.2731731	0.0726101	47	13	9.7994370	10.2005630	47
14	9.7270273	9.9273103	0.2729727	0.0726897	46	14	9.7997170	10.2002830	46
15	9.7272276	9.9272306	0.2727724	0.0727694	45	15	9.7999970	10.2000030	45
16	9.7274278	9.9271509	0.2725722	0.0728491	44	16	9.8002769	10.1997231	44
17	9.7276278	9.9270711	0.2723722	0.0729289	43	17	9.8005567	10.1994433	43
18	9.7278277	9.9269913	0.2721723	0.0730087	42	18	9.8008365	10.19916[illegible]5	42
19	9.7280275	9.9269114	0.2719725	0.0730886	41	19	9.8011161	10.1984839	41
20	9.7282271	9.9268314	0.2717729	0.0731686	40	20	9.8013957	10.1986043	40
21	9.7284267	9.9267514	0.2715733	0.0732486	39	21	9.8016752	10.1983248	39
22	9.7286260	9.9266714	0.2713740	0.0733286	38	22	9.8019546	10.1980454	38
23	9.7288253	9.9265913	0.2711747	0.0734087	37	23	9.8022340	10.1977660	37
24	9.7290244	9.9205112	0.2709756	0.0734888	36	24	9.8025133	10.1974867	36
25	9.7292234	9.9264310	0.2707766	0.0735690	35	25	9.8027925	10.1972075	35
26	9.7294223	9.9263506	0.2705777	0.0736493	34	26	9.8030716	10.1969284	34
27	9.7296211	9.9262704	0.2703790	0.0737296	33	27	9.8033506	10.1966494	33
28	9.7298197	9.9261901	0.2701803	0.0738099	32	28	9.8036296	10.1963704	32
29	9.7300182	9.9261096	0.2699818	0.0738904	31	29	9.8039685	10.1960915	31
30	9.7302165	9.9260292	0.2697835	0.0739708	30	30	9.8041873	10.1958127	30
31	9.7304148	9.9259487	0.2695852	0.0740513	29	31	9.8044661	10.1955339	29
32	9.7306129	9.9258681	0.2693871	0.0741319	28	32	9.8047447	10.1952553	28
33	9.7308109	9.9257875	0.2691891	0.0742125	27	33	9.8050233	10.1949767	27
34	9.7310087	9.9257069	0.2689913	0.0742931	26	34	9.8053019	10.1946981	26
35	9.7312064	9.9256261	0.2687935	0.0743739	25	35	9.8055803	10.1944197	25
36	9.7314040	9.9255458	0.2685960	0.0744546	24	36	9.8058587	10.1941413	24
37	9.7316015	9.9254646	0.2683985	0.0745354	23	37	9.8061370	10.1938630	23
38	9.7317989	9.9253837	0.2682011	0.0746163	22	38	9.8064152	10.1935848	22
39	9.7319961	9.9253028	0.2680039	0.0746972	21	39	9.8056933	10.1933067	21
40	9.7321932	9.9252213	0.2678068	0.0747782	20	40	9.8069714	10.1930286	20
41	9.7323902	9.9251408	0.2676098	0.0748592	19	41	9.8072494	10.1927506	19
42	9.7325870	9.9250597	0.2674130	0.0749403	18	42	9.8075273	10.1924727	18
43	9.7327838	9.9249786	0.2672163	0.0750214	17	43	9.8078052	10.1921948	17
44	9.7329803	9.9248974	0.2670197	0.0751026	16	44	9.8080829	10.1919171	16
45	9.7 31768	9.9248161	0.2668232	0.0751839	15	45	9.8083606	10.1916394	15
46	9.7333731	9.9247349	0.2666269	0.0752651	14	46	9.8086383	10.1913617	14
47	9.7335693	9.9246535	0.2664307	0.07[illegible]3465	13	47	9.8089158	10.1910842	1
48	9.7337654	9.9245721	0.2662346	0.0754279	12	48	9.8091933	10.1908067	12
49	9.7339614	9.9244907	0.2660386	0.0755093	11	49	9.8094707	10.1905293	11
50	9.7341572	9.9244092	0.2658428	0.0755908	10	50	9.8097480	10.1902520	10
51	9.7343529	9.9243277	0.2656471	0.0756723	9	51	9.8100253	10.1899747	9
52	9.7345485	9.9242461	0.2654515	0.0727539	8	52	9.810[illegible]025	10.1896975	8
53	9.7347440	9.9241644	0.2652560	0.0758956	7	53	9.8105796	10.1894204	7
54	9.7349393	9.9240827	0.2650607	0.0759173	6	54	9.8108566	10.1895434	6
55	9.7351345	9.9240010	0.2648655	0.0759990	5	55	9.8111336	10.1883664	5
56	9.7353296	9.9239191	0.2646704	0.0760809	4	56	9.8114105	10.1885895	4
57	9.7355246	9.9238373	0.2644754	0.0761627	3	57	9.8116873	10.1883127	3
58	9.7357195	9.9237554	0.2642805	0.0762446	2	58	9.8119641	10.1880359	2
59	9.7359142	9.9236734	0.2640858	0.0763266	1	59	9.8122408	10.[illegible]877592	1
60	9.7361088	9.9235914	0.2638912	0.0764086	0	60	9.8125174	10.1874826	0
			Co.Arith.	Sign.				Tangent.	

D.	Sine.	Co.Arith.					Tangent.		
0	9.7361088	9.9235914	0.2638912	0.0764086	60	0	9.8125174	10.1874826	60
1	9.7363032	9.9235093	0.2636968	0.0764907	59	1	9.8127939	10.1872061	59
2	9.7364976	9.9234272	0.2635024	0.0765728	58	2	9.8130704	10.1869296	58
3	9.7366918	9.92334[illegible]0	0.2633082	0.0766550	57	3	9.8133468	10.1866532	57
4	9.7468859	9.9232528	0.2631141	0.0767372	56	4	9.8136231	10.1863769	56
5	9.7370799	9.9231805	0.2629201	0.0768195	55	5	9.8138993	10.1861007	55
6	9.7372737	9.9230982	0.2627263	0.0769018	54	6	9.8141755	10.1858245	54
7	9.7374675	9.9230158	0.2625325	0.0769842	53	7	9.8144516	10.1855484	53
8	9.7376611	9.92293[illegible]4	0.2623389	0.0770666	52	8	9.8147277	10.1852723	52
9	9.7378546	9.9228509	0.2621454	0.0771491	51	9	9.8150036	10.1849964	51
10	9.7380479	9.9227684	0.2619521	0.0772316	50	10	9.8152795	10.1847205	50
11	9.7382412	9.9226858	0.2617588	0.0773142	49	11	9.8155554	10.1844446	49
12	9.7384313	9.9226032	0.2615657	0.0773969	48	12	9.8158311	10.1841189	48
13	9.7385273	9.9225205	0.2614727	0.0774795	47	13	9.8161068	10.1838932	47
14	9.7388201	9.9224377	0.2611799	0.0775623	46	14	9.8163824	10.1836176	46
15	9.7390129	9.9223549	0.2609871	0.0776451	45	15	9.8166580	10.183342[illegible]	45
16	9.7392055	9.9222721	0.2607945	0.0777279	44	16	9.8169335	10.1830665	44
17	9.7393980	9.9221891	0.2606020	0.0778109	43	17	9.8172089	10.1827911	43
18	9.7395904	9.9221062	0.2604096	0.0778938	42	18	9.8174842	10.1825158	42
19	9.7397827	9.9220232	0.2602173	0.0777968	41	19	9.8177597	10.1822405	41
20	9.7399748	9.9219401	0.2600252	0.0780599	40	20	9.8180347	10.1819653	40
21	9.7401663	9.9218570	0.2598332	0.0781430	39	21	9.8183098	10.1816902	39
22	9.7403587	9.9217738	0.2596413	0.0782262	38	22	9.8185[illegible]4[illegible]	10.1814151	38
23	9.7405505	9.9216905	0.2594495	0.0783094	37	23	9.8188599	10.1811401	37
24	9.7407421	9.9216073	0.2592579	0.0783927	36	24	9.8191348	10.1808652	36
25	9.7409337	9.9215240	0.2590663	0.0784760	35	25	9.8194096	10.1805904	35
26	9.7411251	9.9214406	0.2588749	0.0785594	34	26	9.8196844	10.1803155	44
27	9.7413164	9.9213572	0.2586836	0.0786428	33	27	9.8199592	10.1800408	33
28	9.7415075	9.9212737	0.2584925	0.0787263	32	28	9.8102338	10.1797662	32
29	9.7416986	9.9211902	0.2583014	0.0788068	31	29	9.8205084	10.1794916	31
30	9.7418895	9.9211066	0.2581105	0.0788934	30	30	9.8207829	10.1792171	30
31	9.7420803	9.9210229	0.2579197	0.0789771	29	31	9.8210574	10.1789426	29
32	9.7422710	9.9209393	0.2577290	0.0790607	28	32	9.8213317	10.1786683	28
33	9.7424616	9.9208555	0.2575384	0.0791445	27	33	9.8216060	10.1783940	27
34	9.7426520	9.9207717	0.2573480	0.0792283	26	34	9.8218803	10.1781197	26
35	9.7428423	9.9206878	0.2571577	0.0793122	25	35	9.8221545	10.1778455	25
36	9.7430325	9.9206039	0.2569675	0.0793961	24	36	9.8224286	10.1775714	24
37	9.7432226	9.9205200	0.2567774	0.0794800	23	37	9.8227026	10.1772974	23
38	9.7434126	9.9204360	0.2565874	0.0795640	22	38	9.8229766	10.1770234	22
39	9.7436024	9.9203519	0.2563976	0.0796481	21	39	9.8232505	10.1767495	21
40	9.7437921	9.9202678	0.2562079	0.0797322	20	40	9.8235244	10.1764756	20
41	9.7439817	9.9201836	0.2560183	0.0798164	19	41	9.8237981	10.1762019	19
42	9.7441712	9.9200994	0.2558288	0.0799006	18	42	9.8240719	10.1759281	18
43	9.7443606	9.9200151	0.2556394	0.0899849	17	43	9.8243455	10.1756[illegible]45	17
44	9.7445498	9.9199308	0.2554502	0.0800692	16	44	9.8246191	10.1753809	16
45	9.7447390	9.9198464	0.2552610	0.0801536	15	45	9.8248926	10.1751074	15
46	9.7449280	9.9197619	0.2550720	0.0802381	14	46	9.8251660	10.1748340	14
47	9.7451169	9.91967[illegible]5	0.2548831	0.0803225	13	47	9.8254394	10.1745606	1
48	9.7453056	9.9195929	0.2546944	0.0804071	12	48	9.8257127	10.1742873	12
49	9.7454943	9.9195083	0.2545057	0.0804917	11	49	9.8259860	10.1740140	11
50	9.7456828	9.9194237	0.2543172	0.0805763	10	50	9.8262592	10.1737408	10
51	9.7478712	9.9193390	0.2541288	0.0806610	9	51	9.8265323	10.1734677	9
52	9.7460595	9.9192542	0.2539405	0.0807458	8	52	9.8268053	10.1731947	8
53	9.7462477	9.9191694	0.2537523	0.0808306	7	53	9.8270783	10.1729217	7
54	9.7464358	9.9190845	0.2535642	0.0809155	6	54	9.8273513	10.1726487	6
55	9.7466237	9.9189996	0.2533763	0.0810004	5	55	9.8276241	10.1723759	5
56	9.7468115	9.9189146	0.2531885	0.0810854	4	56	9.8278969	10.1721031	4
57	9.7469992	9.9188296	0.2530008	0.0811704	3	57	9.8281696	10.1718304	3
58	9.7471868	9.9187445	0.2528132	0.0812555	2	58	9.8284423	10.1715[illegible]77	2
59	9.7473743	9.9186594	0.2526257	0.0813406	1	59	9.8287149	10.1712851	1
60	9.7475617	9.9185742	0.2524383	0.0814258	0	60	9.8289874	10.1710126	0
			Co.Arith.	Sine.				Tangent.	

D.	Sine.	Co.Arith.					Tangent.		
0	9.7475617	9.9185742	0.2524383	0.0814258	60	0	9.8289874	10.1710126	60
1	9.7477489	9.9184890	0.2522511	0.0815110	59	1	9.8292599	10.1707401	59
2	9.7479360	9.9184037	0.2520640	0.0815963	58	2	9.8295323	10.1704677	58
3	9.7481230	9.9183183	0.2518770	0.0816817	57	3	9.8298047	10.1701953	57
4	9.7483099	9.9182329	0.2516901	0.0817671	56	4	9.8300769	10.1699231	56
5	9.7484967	9.9181475	0.2515033	0.0818525	55	5	9.8303492	10.1696508	55
6	9.7486833	9.9180620	0.2513167	0.0819380	54	6	9.8306213	10.1693787	54
7	9.7488693	9.9179764	0.2511302	0.0820236	53	7	9.8308934	10.1691066	53
8	9.7490562	9.9178908	0.2509438	0.0821092	52	8	9.8311654	10.1688346	52
9	9.7492425	9.9178051	0.2507575	0.0821949	51	9	9.8314374	10.1685626	51
10	9.7494287	9.9177194	0.2505713	0.0822806	50	10	9.8317093	10.1682907	50
11	9.7496148	9.9176336	0.2503852	0.0823664	49	11	9.8319811	10.1680189	49
12	9.7498007	9.9175478	0.2501993	0.0724522	48	12	9.8322529	10.1677471	48
13	9.7499866	9.9174619	0.2500134	0.0825381	47	13	9.8325246	10.1674754	47
14	9.7501723	9.9173760	0.2498277	0.0826240	46	14	9.8327963	10.1672037	46
15	9.7503579	9.9172900	0.2496421	0.0827100	45	15	9.8330679	10.1669321	45
16	9.7505434	9.9172040	0.2494566	0.0827960	44	16	9.8333394	10.1666606	44
17	9.7507287	9.9171179	0.2492713	0.0828821	43	17	9.8336109	10.1663891	43
18	9.7509140	9.9170317	0.2490860	0.0829683	42	18	9.8338823	10.1661177	42
19	9.7510991	9.9169455	0.2489009	0.0830545	41	19	9.8341536	10.1658464	41
20	9.7512842	9.9168593	0.2487158	0.0831407	40	20	9.8344249	10.1655751	40
21	9.7514691	9.9167730	0.2485309	0.0832270	39	21	9.8346961	10.1653039	39
22	9.7516538	9.9166866	0.2483462	0.0833134	38	22	9.8349673	10.1650327	38
23	9.7518385	9.9166002	0.2481615	0.0833998	37	23	9.8352384	10.1647616	37
24	9.7520231	9.9165137	0.2479769	0.0834863	36	24	9.8355094	10.1644906	36
25	9.7522075	9.9164272	0.2477925	0.0835728	35	25	9.8357804	10.1642196	35
26	9.7523919	9.9163406	0.2476081	0.0836594	34	26	9.8360513	10.1639487	34
27	9.7525761	9.9162539	0.1474239	0.0837461	33	27	9.8363221	10.1636779	33
28	9.7527602	9.9161673	0.2472398	0.0838327	32	28	9.8365929	10.1634071	32
29	9.7529442	9.9160805	0.2470558	0.0839195	31	29	9.8368636	10.1631364	31
30	9.7531280	9.9159937	0.2468720	0.0840063	30	30	9.8371343	10.1628657	30
31	9.7533118	9.9159069	0.2466882	0.0840931	29	31	9.8374049	10.1625951	29
32	9.7534954	9.9158200	0.2465046	0.0841800	28	32	9.8376755	10.1623245	28
33	9.7536790	9.9157330	0.2463210	0.0842670	27	33	9.8379460	10.1620540	27
34	9.7538624	9.9156460	0.2461376	0.0843540	26	34	9.8382164	10.1617836	26
35	9.7530457	9.9155589	0.2459543	0.0844411	25	35	9.8384867	10.1615133	25
36	9.7542288	9.9154718	0.2457712	0.0845282	24	36	9.8387571	10.1612429	24
37	9.7544119	9.9153846	0.2455881	0.0846154	23	37	9.8390273	10.1609727	23
38	9.7545949	9.9152974	0.2454051	0.0847026	22	38	9.8399275	10.1607025	22
39	9.7547777	9.9152101	0.2452223	0.0847899	21	39	9.8395676	10.1604324	21
40	9.7549604	9.9151228	0.2450396	0.0848772	20	40	9.8398377	10.1601623	20
41	9.7551431	9.9150354	0.2848569	0.0849646	19	41	9.8401077	10.1598923	19
42	9.7553256	9.9149479	0.2446744	0.0850521	18	42	9.8403776	10.1596224	18
43	9.7555080	9.9148604	0.2444920	0.0851396	17	43	9.8406475	10.1593525	17
44	9.7556902	9.9147729	0.2443098	0.0852271	16	44	9.8409174	10.1590826	16
45	9.7558724	9.9146852	0.2441276	0.0853148	15	45	9.8411871	10.1588129	15
46	9.7560544	9.9145976	0.2439456	0.0854024	14	46	9.8414569	10.1585431	14
47	9.7562364	9.9145099	0.2437636	0.0854901	13	47	9.8417265	10.1582735	13
48	9.7564182	9.9144221	0.2435818	0.0855779	12	48	9.8419961	10.1580039	12
49	9.7565999	9.9143342	0.2434001	0.0856658	11	49	9.8422657	10.1577343	11
50	9.7567815	9.9142464	0.2432185	0.0857536	10	50	9.8425351	10.1574649	10
51	9.7569630	9.9141584	0.2430370	0.0858416	9	51	9.8428046	10.1571954	9
52	9.7571444	9.9140704	0.2428556	0.0859296	8	52	9.8430739	10.1569261	8
53	9.7573256	9.9139824	0.2426744	0.0860176	7	53	9.8433432	10.1566568	7
54	9.7575068	9.9138943	0.2424932	0.0861057	6	54	9.8436125	10.1563875	6
55	9.7576878	9.9138061	0.2423122	0.0861939	5	55	9.8438817	10.1561183	5
56	9.7578687	9.9137179	0.2421313	0.0862821	4	56	9.8441508	10.1558492	4
57	9.7580495	9.9136296	0.2419505	0.0863704	3	57	9.8444199	10.1555801	3
58	9.7582302	9.9135413	0.2417698	0.0864587	2	58	9.8446889	10.1553111	2
59	9.7584108	9.9134530	0.2415892	0.0865471	1	59	9.8449579	10.1550421	1
60	9.7585913	9.9133645	0.2414087	0.0866355	0	60	9.8452268	10.1547732	0
			Co.Arith.	Sine.				Tangent.	

D.	Sine.	Co.Arith.					Tangent.		
0	9.7585913	9.9133645	0.2414087	0.0866355	60	0	9.8452268	10.1 47732	60
1	9.7587717	9.9132760	9.2412283	0.0867240	59	1	9.8454956	10.1545044	59
2	9.7589519	9.913 875	0 2410481	0.0868125	58	2	9.8457644	10.1542356	58
3	9.7591321	9.9130989	0.2408679	0.0869011	57	3	9.8460332	10.1539668	57
4	9.7593121	9.9130102	0.2406879	0.0869898	56	4	9.8463018	10.1536982	56
5	9.7594920	9.9129215	0.2405080	0.0870785	55	5	9.8465705	10.1534295	55
6	9.7596718	9.9128328	0.2403282	0.0871672	54	6	9.8468390	10.1531610	54
7	9.7598515	9.9127440	0.2401485	0.0872560	53	7	9.8471075	10.1528925	53
8	9.7600311	9.9126551	0.2399689	0.0873449	52	8	9.8473760	10.1526248	52
9	9.7602106	9.9125662	0.2397894	0.0874338	51	9	9.8476444	10.1523556	51
10	9.7603899	9.9124772	0.2396101	0.0875228	50	10	9.8479127	10.1520873	50
11	9.7605692	9.9123882	0.2394308	0.0876118	49	11	9.8481810	10.1518190	49
12	9.7607483	9.9122991	0.2392517	0.0777009	48	12	9.8484492	10.1515508	48
13	9.7609274	9.9122099	0.2390726	0.0877901	47	13	9.8487174	10.1512826	47
14	9.7611063	9.9121207	0.2388937	0.0878793	46	14	9.8489855	10.1510145	46
15	9.7612851	9.9120315	0.2387149	0.0879685	45	15	9.8492536	10.1507464	45
16	9.7614638	9.9119422	0.2385362	0.0980578	44	16	9.7495216	10.1504784	44
17	9.7616424	9.9118528	0.2383576	0.0881472	43	17	9.8497896	10.1502104	43
18	9.7618208	9.9117634	0.2381792	0.0882366	42	18	9.8500575	10.1499425	42
19	9.7619992	9.9116739	0.2380008	0.0883261	41	19	9.8503253	10.1496747	41
20	9.7621775	9.9115844	0.2378225	0.0884156	40	20	9.8505931	10.1494069	40
21	9.7623556	9.9114948	0.2376444	0.0885052	39	21	9.8508608	10.1491392	39
22	9.7625337	9.9114051	0.2374663	0.0885949	38	22	9.8511285	10.1488715	38
23	9.7627116	9.9113155	0.2372884	0.0886845	37	23	9.8513961	10.1486039	37
24	9.7628894	9.9112257	0.2371106	0.0887743	36	24	9.8516637	10.1483363	36
25	9.7630671	9.9111359	0.2369329	0.0888641	35	25	9.8519312	10.1480688	35
26	9.7632447	9.9110460	0.2367553	0.0889540	34	26	9.8521987	10.1478043	34
27	9.7634222	9.9019561	0.2365778	0.0890439	33	27	9.8524661	10.1475339	33
28	9.7635996	9.9018661	0.2364004	0.0891339	32	28	9.8527335	10.1472665	32
29	9.7637769	9.9017761	0.2362231	0.0892239	31	29	9.8530008	10.1469992	31
30	9.7639540	9.9016860	0.2360460	0.0893140	30	30	9.8532680	10.1457320	30
31	9.7641311	9.9105959	0.2358689	0.0894041	29	31	9.8535352	10.1464648	29
32	9.7643080	9.9105057	0.2356920	0.0894943	28	32	9.8538023	10.1461977	28
33	9.7644849	9.9104155	0.2355151	0.0895845	27	33	9.8520694	10.1459306	27
34	9.7646616	9.9103251	0.2353384	0.0896749	26	34	9.8543365	10.1456635	26
35	9.7648382	9.9102348	0.2351618	0.0897652	25	35	9.8546034	10.1453966	25
36	9.7650147	9.9101444	0.2349853	0.0898556	24	36	9.8548704	10.1451296	24
37	9.76 1911	9.9100549	0.2348089	0.0899461	23	37	9.8551372	10.1448628	23
38	9.7653674	9.9099634	0.2346326	0.0900366	22	38	9.8554041	10.1445959	22
39	9.7655436	9.9098728	0.2344564	0.0901272	21	39	9.8556708	10.1443292	21
40	9.7657197	9.9097821	0.2342803	0.0902179	20	40	9.8559376	10.1440624	20
41	9.7658957	9.9096915	0.2341043	0.0903085	19	41	9.8562042	10.1437958	19
42	9.7660715	9.9096007	0.2339285	0.0903993	18	42	9.8564708	10.1435292	18
43	9.7662473	9.9093099	0.2337527	0.0904901	17	43	9.8567374	10.1432626	17
44	9.7664229	9.9094190	0.2335771	0.0905810	16	44	9.8570039	10.1429961	16
45	9.7665985	9.9093281	0.2334015	0.0906719	15	45	9.8572704	10.1427296	15
46	9.7667739	9.9092371	0.2332261	0.0907629	14	46	9.8575368	10.1424632	14
47	9.7669492	9.9091461	0.2330508	0.0908539	13	47	9.8578031	10.1421969	13
48	9.7671244	9.9090550	0.2328756	0.0909450	12	48	9.8580694	10.1419306	12
49	9.7672996	9.9089639	0.2327004	0.0910361	11	49	9.8583357	10.1416643	11
50	9.7674746	9.9088727	0.2525254	0.0911273	10	50	9.8586019	10.1413981	10
91	9.7676494	9.9087814	0.2323506	0.0912186	9	51	9.8588680	10.1411320	9
52	9.7678242	9.9085901	0.2321758	0.0913099	8	52	9.8591341	10.1408659	8
53	9.7679989	9.9085980	0.2320011	0.0914012	7	53	9.8594002	10.1405998	7
54	9.7681735	9.9085073	0.2318265	0.0914927	6	54	9.8596661	10.1403339	6
55	9.7683480	9.9084159	0.2316520	0.0915841	5	55	9.8599321	10.1400679	5
56	9.7685223	9.9083243	0.2314777	0.0916757	4	56	9.8601980	10.1398020	4
57	9.7686966	9.9082327	0.2313034	0.0917673	3	57	9.8604638	10.1395362	3
58	9.7688707	9.9081411	0.2311293	0.0918589	2	58	9.8607296	10.1392704	2
59	9.7690448	9.9080494	0.2309552	0.0919506	1	59	9.8609954	10.1390046	1
60	9.7692187	9.9079576	0.2307813	0.0920424	0	60	9.8612610	10.1387390	0
			Co.Arith.	Sine.				Tangent.	

D.	Sign.	Co.Arith.					Tangent.		
0	9.7692186	9.9079576	0.2307813	0.0920424	60	0	9.8612610	10.1387390	60
1	9.7693925	9.9078558	0.2306075	0.0921342	59	1	9.8615267	10.1384733	59
2	9.7695662	9.9077740	0.2304338	0.0922260	58	2	9.8617923	10.1382077	58
3	9.7697398	9.9076820	0.2302602	0.0923180	57	3	9.8920578	10.1379422	57
4	9.7699134	9.9075901	0.2300866	0.0924099	56	4	9.8623233	10.1376767	56
5	9.7700868	9.9074980	0.2299132	0.0925020	55	5	9.8625887	10.1374113	55
6	9.7702601	9.9074059	0.2297399	0.0925941	54	6	9.8628541	10.1371459	54
7	9.7704332	9.9073133	0.2295668	0.0926862	53	7	9.8631195	10.1368805	53
8	9.7706063	9.9072216	0.2293937	0.0927784	52	8	9.8633848	10.1366152	52
9	9.7707793	9.9071293	0.2292207	0.0928707	51	9	9.8636500	10.1363500	51
10	9.7709522	9.9070370	0.2290478	0.0929630	50	10	9.8639152	10.1360848	50
11	9.7711249	9.9069446	0.2288751	0.0939554	49	11	9.8641803	10.1358197	49
12	9.7712976	9.9068522	0.2287024	0.0931478	48	12	9.8644454	10.1355546	48
13	9.7714702	9.9067597	0.2285298	0.0632403	47	13	9.8647105	10.1352895	47
14	9.7716426	9.9066671	0.2283576	0.0933329	46	14	9.8649755	10.1350245	46
15	9.7718150	9.9065745	0.2281850	0.0934255	45	15	9.8652404	10.1347596	45
16	9.7719872	9.9064819	0.2280128	0.0935181	44	16	9.7655053	10.1344947	44
17	9.7721593	9.9063892	0.2278487	0.0936108	43	17	9.8657702	10.1342298	43
18	9.7723314	9.9062964	0.2276686	0.0937036	42	18	9.8660350	10.1339650	42
19	9.7725033	9.9062036	0.2274967	0.0937964	41	19	9.8662997	10.1337003	41
20	9.7726751	9.9061107	0.2273249	0.0938893	40	20	9.8665644	10.1334356	40
21	9.7728468	9.9060177	0.2271532	0.0939823	39	21	9.8668291	10.1331709	39
22	9.7730815	9.9059247	0.2269815	0.0940753	38	22	9.8670937	10.1329063	38
23	9.7731900	9.9058317	0.2268100	0.0941683	37	23	9.8673583	10.1326417	37
24	9.7733614	9.9057386	0.2266386	0.0942614	36	24	9.8676228	10.1323772	36
25	9.7735327	9.9056454	0.2264673	0.0943546	35	25	9.8678873	10.1327127	35
26	9.7737039	9.9055522	0.2262961	0.0944478	34	26	9.8681517	10.1318483	34
27	9.7748749	9.9054589	0.2261251	0.0945411	33	27	9.8684160	10.1315840	33
28	9.774045[illegible]	9.9053656	0.2259541	0.0946344	32	28	9.8686804	10.1313196	32
29	9.7742168	9.9052722	0.2257832	0.0947278	31	29	9.8689446	10.1310554	31
30	9.7743876	9.9051787	0.2256124	0.0948213	30	30	9.8692089	10.1307911	30
31	9.7745583	9.9050852	0.2254417	0.0949148	29	31	9.8694731	10.1305269	29
32	9.7747288	9.9049916	0.2252712	0.0950084	28	32	9.8697372	10.1302628	28
33	9.7748993	9.9048980	0.2251007	0.0951020	27	33	9.8700013	10.1299987	27
34	9.7750697	9.9048043	0.2249303	0.0951957	26	34	9.8702653	10.1297347	26
35	9.7752399	9.9047106	0.2247601	0.0952894	25	35	9.8705293	10.1294707	25
36	9.7754101	9.9046168	0.2245899	0.0953832	24	36	9.8707933	10.1292067	24
37	9.7755801	9.9045230	0.2244199	0.0954770	23	37	9.8710572	10.1289428	23
38	9.7753501	9.9044291	0.2242499	0.0955709	22	38	9.8713210	10.1286790	22
39	9.7759199	9.9043351	0.2240801	0.0956649	21	39	9.8715848	10.1284192	21
40	9.7760897	9.9042411	0.2239103	0.0957589	20	40	9.8718486	10.1281514	20
41	9.7762593	9.9041470	0.2237407	0.0958530	19	41	9.8721123	10.1278877	19
42	9.7764289	9.9040529	0.2235711	0.0959471	18	42	9.8723759	10.1276240	18
43	9.7765983	9.9039587	0.2234017	0.0960413	17	43	9.8726396	10.1273604	17
44	9.7767676	9.9038644	0.2232324	0.0961350	16	44	9.8729032	10.1270968	16
45	9.7769369	9.9037701	0.2230631	0.0962299	15	45	9.8731668	10.1268332	15
46	9.7771060	9.9036757	0.2228940	0.0963243	14	46	9.8734302	10.1265698	14
47	9.7772750	9.9035813	0.2227250	0.0964187	13	47	9.8736937	10.1263063	13
48	9.7774439	9.9034868	0.2225561	0.0965132	12	48	9.8739571	10.1260429	12
49	9.7776128	9.9033923	0.2223872	0.0966077	11	49	9.8742204	10.1257796	11
50	9.7777815	9.9032977	0.2222185	0.0967023	10	50	9.8744838	10.1255162	10
51	9.7779501	9.9032031	0.2220499	0.0967967	9	51	9.8747470	10.1252530	9
52	9.7781186	9.9031084	0.2218814	0.0968916	8	52	9.8750102	10.1249898	8
53	9.7782870	9.9030136	0.2217130	0.0969864	7	53	9.8752734	10.1247266	7
54	9.7784553	9.9029188	0.2215447	0.0970812	6	54	9.875536	10.1244635	6
55	9.7786235	9.9028239	0.2213765	0.0971761	5	55	9.8757996	10.1242004	5
56	9.7787916	9.9027289	0.2212084	0.0972711	4	56	9.8760627	10.1239373	4
57	9.7789596	9.9026339	0.2210404	0.0973661	3	57	9.8763257	10.1236743	3
58	9.7791275	9.9025389	0.2208725	0.0974611	2	58	9.8765886	10.1234114	2
59	9.7792953	9.9024438	0.2207047	0.0975562	1	59	9.8768515	10.1231485	1
60	9.7794630	9.9023486	0.2205370	0.0976514	0	60	9.8771144	10.1228856	0
			Co.Arith.	Sign.				Tangent.	

Degrees 37.

D.	Sign.	Co. Arith.	Co.Arith.	Sign.			Tangent.	Tangent.	
0	9.7794630	9.9023486	0.2205370	0.0976514	60	0	9.8771144	10.1228856	60
1	9.7796306	9.9022534	0.2203694	0.0977466	59	1	9.8773772	10.1226228	59
2	9.7797981	9.9021581	0.2202019	0.0978419	58	2	9.8776400	10.1223600	58
3	9.7799655	9.9020628	0.2200345	0.0979372	57	3	9.8779027	10.1220973	57
4	9.7801328	9.9019674	0.2198672	0.0980326	56	4	9.8781654	10.1218346	56
5	9.7803000	9.9018719	0.2197000	0.0981281	55	5	9.8784281	10.1215719	55
6	9.7804671	9.9017764	0.2195329	0.0982236	54	6	9.8786907	10.1213093	54
7	9.7806341	9.9016808	0.2193659	0.0983192	53	7	9.8787933	10.1210467	53
8	9.7808010	9.9015852	0.2191990	0.0984148	52	8	9.8792158	10.1207842	52
9	9.7809677	9.9014895	0.2190323	0.0985105	51	9	9.8794782	10.1205218	51
10	9.7811344	9.9013938	0.2188656	0.0986062	50	10	9.8797407	10.1202593	50
11	9.7813010	9.9012980	0.2186990	0.0987020	49	11	9.8800031	10.1199959	49
12	9.7814675	9.9012021	0.2185325	0.0987979	48	12	9.8802654	10.1197346	48
13	9.7816339	9.9011062	0.2183961	0.0988938	47	13	9.8805277	10.1194723	47
14	9.7818002	9.9010102	0.2181998	0.0989898	46	14	9.8807900	10.1192100	46
15	9.7819664	9.9009142	0.2280336	0.0990858	45	15	9.8810522	10.1189478	45
16	9.7821324	9.9008181	0.2178676	0.0991819	44	16	9.8813144	10.1186856	44
17	9.7822984	9.9007219	0.2177016	0.0992781	43	17	9.8815765	10.1184235	43
18	9.7824643	9.9006257	0.2175357	0.0993743	42	18	9.8818386	10.1181614	42
19	9.7826301	9.9005294	0.2173699	0.0994705	41	19	9.8821007	10.1178993	41
20	9.7827958	9.9004331	0.2172042	0.0995669	40	20	9.8823627	10.1176373	40
21	9.7829614	9.9003367	0.2170386	0.0996633	39	21	9.8826246	10.1173754	39
22	9.7831268	9.9094403	0.2168732	0.0997597	38	22	9.8828866	10.1171134	38
23	9.7332922	9 9001437	0.2167078	0.0998562	37	23	9.8831484	10.1168516	37
24	9.7834575	9.9000472	0.2165425	0.0999528	36	24	9.8834103	10.1165897	36
25	9.7836227	9.8999506	0.2163773	0.1000494	35	25	9.8836721	10.1163279	35
26	9.7837878	9.8998539	0.2162122	0.1001461	34	26	9.8839338	10.1160662	34
27	9.7839528	9.8997572	0.2160472	0.1002428	33	27	9.8841956	10.1158084	33
28	9.7841177	9.8996604	0.2158823	0.1003396	32	28	9.8844572	10.1155428	32
29	9.7842824	9.8995636	0.2157176	0.1004364	31	29	9.8847189	10.1152811	31
30	9.7844471	9.8994667	0.2155529	0.1005333	30	30	9.8849805	10.1150195	30
31	9.7846117	9.8993697	0.2153883	0.1006303	29	31	9.8852420	10.1147580	29
32	9.7847762	9.8992727	0.2152238	0.1007273	28	32	9.8855035	10.1144965	28
33	9.7849406	9.8991756	0.2150594	0.1008244	27	33	9.8857650	10.1142350	27
34	9.7851043	9.8990784	0.2148951	0.1009210	26	34	9.8860264	10.1139736	26
35	9.7852691	9.8989812	0.2147309	0.1010188	25	35	9.8862878	10.1137122	25
36	9.7854332	9.8988840	0.2145668	0.1011160	24	36	9.8865492	10.1134508	24
37	9.7855972	9.8987867	0.2144028	0.1012133	23	37	9.8868105	10.1131895	23
38	9.7857611	9.8986893	0.2142389	0.1013107	22	38	9.8870718	10.1129282	22
39	9.7859249	9.8985919	0.2140751	0.1014081	21	39	9.8873330	10.1126670	21
40	9.7860886	9.8984944	0.2139114	0.1015056	20	40	9.8875942	10.1124058	20
41	9.7862522	9.8983968	0.2137478	0.1016032	19	41	9.8878554	10.1121446	19
42	9.7864157	9.8982992	0.2135843	0.1017008	18	42	9.8881165	10.1118835	18
43	9.7865791	9.8982915	0.2134209	0.1017985	17	43	9.8883775	10.1116225	17
44	9.7867424	9.8981038	0.2132576	0.1018962	16	44	9.8886386	10.1113614	16
45	9.7869056	9.8980060	0.2130944	0.1019940	15	45	9.8888996	10.1111004	15
46	9.7870687	9.8979082	0.2129313	0.1020918	14	46	9.8891605	10.1108395	14
47	9.7872317	9.8978103	0.2127683	0.1021897	13	47	9.8894214	10.1105786	13
48	9.7873946	9.8977123	0.2126054	0.1022877	12	48	9.8896823	10.1103177	12
49	9.7875574	9.8976143	0.2124426	0.1023857	11	49	9.8899432	10.1100568	11
50	9.7877202	9.8975162	0.2122798	0.1024838	10	50	9.8902040	10.1097960	10
51	9.7878828	9.8974181	0.2121172	0.1025819	9	51	9.8904647	10.1095353	9
52	9.7880453	9.8973199	0.2119547	0.1026801	8	52	9.8907254	10.1092746	8
53	9.7882077	9.8972216	0.2117923	0.1027784	7	53	9.8909861	10.1090139	7
54	9.7883701	9.8971233	0.2116299	0.1028767	6	54	9.8912468	10.1087532	6
55	9.7835323	9.8970249	0.2114677	0.1029751	5	55	9.8915074	10.1084926	5
56	9.7886944	9.8969265	0.2113056	0.1030735	4	56	9.8917679	10.1082321	4
57	9.7888565	9.8968280	0.2111435	0.1031720	3	57	9.8920285	10.1079715	3
58	9.7890184	9.8967294	0.2109816	0.1032706	2	58	9.8922890	10.1077110	2
59	9.7891802	9.8966308	0.2108198	0.1033692	1	59	9.8925494	10.1074506	1
60	9.7893420	9.8965321	0.2106580	0.1034679	0	60	9.8928098	10.1071902	0

Degrees 52.

D.	Sine.	Co. Arith.	Co.Arith.	Sine.		D.	Tangent.	Tangent.	
0	9.7893420	9.8965321	0.2106580	0.1034679	60	0	9.8928098	10.1071902	60
1	9.7895036	9.8964334	0.2104964	0.1035666	59	1	9.8930702	10.1069298	59
2	9.7896652	9.8963340	0.2103348	0.1036654	58	2	9.8933306	10.1066594	58
3	9.7898266	9.8962358	0.2101734	0.1037642	57	3	9.8935909	10.1054091	57
4	9.7899880	9.8961369	0.2100120	0.1038631	56	4	9.8938511	10.1061489	56
5	9.7901493	9.8960379	0.2098507	0.1039621	55	5	9.8941114	10.1058886	55
6	9.7903104	9.8959389	0.2096890	0.1040611	54	6	9.8943715	10.1056285	54
7	9.7904715	9.8958398	0.2095285	0.1041602	53	7	9.8946317	10.1053683	53
8	9.7906325	9.8957406	0.2093675	0.1042594	52	8	9.8948918	10.1051082	52
9	9.7907933	9.8956414	0.2092067	0.1043586	51	9	9.8951519	10.1048481	51
10	9.7909541	9.8955422	0.2090459	0.1044578	50	10	9.8954119	10.1045881	50
11	9.7911148	9.8954429	0.2088852	0.1045572	49	11	9.8956719	10.1043281	49
12	9.7912754	9.8953435	0.2087246	0.1046565	48	12	9.8959319	10.1040681	48
13	9.7914359	9.8952440	0.2085641	0.1047560	47	13	9.8961918	10.1038082	47
14	9.7915963	9.8951445	0.2084037	0.1048555	46	14	9.8964517	10.1035483	46
15	9.7917566	9.8950450	0.2082434	0.1049550	45	15	9.8967116	10.1032884	45
16	9.7919168	9.8949453	0.2080832	0.1050547	44	16	9.8969714	10.1030286	44
17	9.7920769	9.8948457	0.2079231	0.1051543	43	17	9.8972312	10.1027688	43
18	9.7922369	9.8947459	0.2077631	0.1052541	42	18	9.8974910	10.1025090	42
19	9.7923968	9.8946461	0.2076032	0.1053539	41	19	9.8977507	10.1022493	41
20	9.7925566	9.8945463	0.2074434	0.1054537	40	20	9.8980104	10.1019896	40
21	9.7927163	9.8944463	0.2072837	0.1055537	39	21	9.8982700	10.1017300	39
22	9.7928760	9.8943464	0.2071240	0.1056536	38	22	9.8985296	10.1014704	38
23	9.7930355	9.8942463	0.2069645	0.1057537	37	23	9.8987892	10.1012108	37
24	9.7931949	9.8941462	0.2068051	0.1058538	35	24	9.8990487	10.1009513	36
25	9.7933543	9.8940461	0.2066457	0.1059539	35	25	9.8993082	10.1006918	35
26	9.7935135	9.8939458	0.2064865	0.1060542	34	26	9.8995677	10.1004323	34
27	9.7936767	9.8938456	0.2063273	0.1061544	33	27	9.8998271	10.1001729	33
28	9.7938317	9.8937452	0.2061683	0.1062548	32	28	9.9000865	10.0999135	32
29	9.7939907	9.8936448	0.2060093	0.1063552	31	29	9.9003459	10.0996541	31
30	9.7941496	9.8935444	0.2058504	0.1064556	30	30	9.9006052	10.0993948	30
31	9.7943083	9.8934439	0.2056917	0.1065561	29	31	9.9008645	10.0991355	29
32	9.7944670	9.8933433	0.2055330	0.1066567	28	32	9.5011237	10.0988763	28
33	9.7946256	9.8932426	0.2053744	0.1067574	27	33	9.9013830	10.0986170	27
34	9.7947841	9.8931419	0.2052159	0.1068581	26	34	9.9016422	10.0983578	26
35	9.7949425	9.8930412	0.2050575	0.1069588	25	35	9.9019013	10.0980987	25
36	9.7951009	9.8929404	0.2048992	0.1070596	24	36	9.9021604	10.0978396	24
37	9.7952596	9.8928395	0.2047410	0.1071605	23	37	9.9024195	10.0975805	23
38	9.7954171	9.8927389	0.2045829	0.1072615	22	38	9.9026786	10.0973214	22
39	9.7955751	9.8926375	0.2044249	0.1073625	21	39	9.9029376	10.0970624	21
40	9.7957330	9.8925365	0.2042670	0.1074635	20	40	9.9031966	10.0968034	20
41	9.7958908	9.8924354	0.2041091	0.1075646	19	41	9.9034555	10.0965445	19
42	9.7960486	9.8923342	0.2039514	0.1076658	18	42	9.9037144	10.0962856	18
43	9.7962062	9.8922329	0.2037938	0.1077671	17	43	9.9039733	10.0960267	17
44	9.7963638	9.8921316	0.2036362	0.1078684	16	44	9.9042321	10.0957679	16
45	9.7965212	9.8920303	0.2034788	0.1079697	15	45	9.9044910	10.0955090	15
46	9.7966786	9.8919289	0.2033214	0.1080711	14	46	9.9047497	10.0952503	14
47	9.7968359	9.8918274	0.2031641	0.1081726	13	47	9.9050085	10.0949915	13
48	9.7969930	9.8917258	0.2030070	0.1082742	12	48	9.9052672	10.0947328	12
49	9.7971501	9.8916242	0.2028499	0.1083758	11	49	9.9055259	10.0944741	11
50	9.7973071	9.8915226	0.2026929	0.1084774	10	50	9.9057845	10.0942155	10
51	9.7974640	9.8914208	0.2025360	0.1085792	9	51	9.9060431	10.0939569	9
52	9.7976208	9.8913191	0.2023792	0.1086809	8	52	9.9063017	10.0936983	8
53	9.7977775	9.8912172	0.2022225	0.1087828	7	53	9.9065603	10.0934397	7
54	9.7979341	9.8911153	0.2020659	0.1088847	6	54	9.9068188	10.0931812	6
55	9.7980906	9.8910133	0.2019094	0.1089867	5	55	9.9070773	10.0929227	5
56	9.7982470	9.8909113	0.2017530	0.1090887	4	56	9.9073357	10.0926643	4
57	9.7984034	9.8908092	0.2015966	0.1091908	3	57	9.9075941	10.0924059	3
58	9.7985596	9.8907071	0.2014404	0.1092929	2	58	9.9078525	10.0921475	2
59	9.7987158	9.8906049	0.2012842	0.1093951	1	59	9.9081109	10.0918891	1
60	9.7988718	9.8905026	0.2011282	0.1094974	0	60	9.9083692	10.0916308	0
			Co.Arith.	Sine.				Tangent.	

D.	Sine.	Co. Arith.					Tangent.		
0	9.7988718	9.8905026	0.2011282	0.1094974	60	0	9.9083692	10.0916308	60
1	9.7990273	9.8904003	0.2009722	0.1095997	59	1	9.9086275	10.0913725	59
2	9.7991835	9.8902979	0.2008164	0.1097021	58	2	9.9088858	10.0911142	58
3	9.7993394	9.8901954	0.2006606	0.1098046	57	3	9.9091440	10.0908560	57
4	9.7994951	9.8900929	0.2005049	0.1099071	56	4	9.9094022	10.0905978	56
5	9.7996507	9.8899903	0.2003493	0.1100097	55	5	9.9096603	10.0903397	55
6	9.7998052	9.8898877	0.2001938	0.1101123	54	6	9.9009185	10.0900815	54
7	9.7999616	9.8897850	0.2000384	0.1102150	53	7	9.9101766	10.0898234	53
8	9.8001169	9.8896822	0.1998831	0.1103178	52	8	9.9104347	10.0895653	52
9	9.8002721	9.8895794	0.1997279	0.1104205	51	9	9.9106927	10.0893073	51
10	9.8004272	9.8894765	0.1995728	0.1105235	50	10	9.9109507	10.0890493	50
11	9.8005823	9.8893736	0.1994177	0.1106264	49	11	9.9112087	10.0887913	49
12	9.8007372	9.8892706	0.1992628	0.1107294	48	12	9.9114666	10.0885334	48
13	9.8008921	9.8891675	0.1991079	0.1108325	47	13	9.9117245	10.0882755	47
14	9.8010468	9.8890644	0.1989532	0.1109325	46	14	9.9119824	10.0880176	46
15	9.8012015	9.8889612	0.1987985	0.1110388	45	15	9.9122403	10.0877597	45
16	9.8013561	9.8888580	0.1986439	0.1111420	44	16	9.9124981	10.0875019	44
17	9.8015106	9.8887547	0.1984894	0.1112453	43	17	9.9127559	10.0872441	43
18	9.8016649	9.8886513	0.1983351	0.1113487	42	18	9.9130137	10.0869863	42
19	9.8018192	9.8885479	0.1981808	0.1114521	41	19	9.9132714	10.0867586	41
20	9.8019735	9.8884444	0.1980265	0.1115556	40	20	9.9135291	10.0864709	40
21	9.8021276	9.8883408	0.1978724	0.1116592	39	21	9.9137868	10.0862132	39
22	9.8022816	9.8882372	0.1977184	0.1117628	38	22	9.9140444	10.0859556	38
23	9.8024355	9.8881335	0.1975645	0.1118665	37	23	9.9143020	10.0856980	37
24	9.8025894	9.8880298	0.1974106	0.1119702	36	24	9.9145596	10.0854404	36
25	9.8027431	9.8879260	0.1972569	0.1120740	35	25	9.9148171	10.0851829	35
26	9.8028968	9.8878221	0.1971032	0.1121779	34	26	9.9150747	10.0849253	34
27	9.8030504	9.8877182	0.1969496	0.1122818	33	27	9.9153322	10.0846678	33
28	9.8032038	9.8876142	0.1967962	0.1123858	32	28	9.9155896	10.0844104	32
29	9.8033572	9.8875102	0.1966428	0.1124898	31	29	9.9158471	10.0841529	31
30	9.8035105	9.8874061	0.1964895	0.1125939	30	30	9.9161045	10.0838955	30
31	9.8736637	9.8873019	0.1963363	0.1126981	29	31	9.9163618	10.0836382	29
32	9.8038168	9.8871977	0.1961832	0.1128023	28	32	9.5166192	10.0833808	28
33	9.8039699	9.8870934	0.1960301	0.1129066	27	33	9.9168765	10.0831235	27
34	9.8041228	9.8869890	0.1958772	0.1130110	26	34	9.9171338	10.0828662	26
35	9.8042757	9.8868846	0.1957243	0.1131154	25	35	9.9173911	10.0826089	25
36	9.8044284	9.8867801	0.1955716	0.1132199	24	36	9.9176483	10.0823517	24
37	9.8045811	9.8866756	0.1954189	0.1133244	23	37	9.9179055	10.0820945	23
38	9.8047336	9.8865710	0.1952664	0.1134290	22	38	9.9181627	10.0818373	22
39	9.8048861	9.8864663	0.1951139	0.1135337	21	39	9.9184198	10.0815802	21
40	9.8050385	9.8863616	0.1949615	0.1136384	20	40	9.9186769	10.0813231	20
41	9.8051908	9.8862568	0.1948092	0.1137432	19	41	9.9189340	10.0810660	19
42	9.8053430	9.8861519	0.1946570	0.1138481	18	42	9.9191911	10.0808089	18
43	9.8054951	9.8860470	0.1945049	0.1139530	17	43	9.9194481	10.0805519	17
44	9.8056472	9.8859420	0.1943528	0.1140580	16	44	9.9197051	10.0802949	16
45	9.8057991	9.8858370	0.1942009	0.1141630	15	45	9.9199621	10.0800379	15
46	9.8059510	9.8857319	0.1940490	0.1142681	14	46	9.9202191	10.0797809	14
47	9.8061027	9.8856267	0.1938973	0.1143733	13	47	9.9204760	10.0795240	13
48	9.8062544	9.8855215	0.1937456	0.1144785	12	48	9.9207329	10.0792671	12
49	9.8064060	9.8854162	0.1935940	0.1145838	11	49	9.9209898	10.0790102	11
50	9.8065575	9.8853109	0.1934425	0.1146891	10	50	9.9212466	10.0787534	10
51	9.8067089	9.8852055	0.1932911	0.1147945	9	51	9.9215034	10.0784966	9
52	9.8068602	9.8851000	0.1931398	0.1149000	8	52	9.9217602	10.0782398	8
53	9.8070114	9.8849945	0.1929886	0.1150055	7	53	9.9220170	10.0779830	7
54	9.8071626	9.8848889	0.1928374	0.1151111	6	54	9.9222737	10.0777263	6
55	9.8073136	9.8847832	0.1926864	0.1152168	5	55	9.9225304	10.0774696	5
56	9.8074646	9.8846775	0.1925354	0.1153225	4	56	9.9227871	10.0772129	4
57	9.8076154	9.8845717	0.1923846	0.1154283	3	57	9.9230437	10.0769563	3
58	9.8077662	9.8844659	0.1922338	0.1155341	2	58	9.9233004	10.0766996	2
59	9.8079169	9.8843599	0.1920831	0.1156401	1	59	9.9235570	10.0764430	1
60	9.8080675	9.8842540	0.1919325	0.1157460	0	60	9.9238135	10.0761865	0
			Co.Arith.	Sine.				Tangent.	

D.	Sine.	Co. Arith.					Tangent.		
0	9.8080675	9.8842540	0.1919325	0.1157460	60	0	9.9238135	10.0761865	60
1	9.8082180	9.8841479	0.1917820	0.1158521	59	1	9.9240701	10.0759299	59
2	9.8083684	9.8840418	0.1916316	0.1159582	58	2	9.9243266	10.0756734	58
3	9.8085188	9.8839357	0.1914812	0.1160643	57	3	9.9245831	10.0754169	57
4	9.8086690	9.8838294	0.1913310	0.1161700	56	4	9.9248395	10.0751604	56
5	9.8088192	9.8837232	0.1911808	0.1162768	55	5	9.9250960	10.0749040	55
6	9.8089692	9.8836168	0.1910308	0.1163832	54	6	9.9253524	10.0746476	54
7	9.8091192	9.8835104	0.1908808	0.1164896	53	7	9.9256088	10.0743912	53
8	9.8092691	9.8834039	0.1907309	0.1165961	52	8	9.9258652	10.0741348	52
9	9.8094189	9.8832974	0.1905811	0.1167026	51	9	9.9261215	10.0738785	51
10	9.8095686	9.8831908	0.1904314	0.1168092	50	10	9.9263778	10.0736222	50
11	9.8097182	9.8830841	0.1902818	0.1169159	49	11	9.9266341	10.0733659	49
12	9.8098678	9.8829774	0.1901322	0.1170226	48	12	9.9268904	10.0731096	48
13	9.8100172	9.8828706	0.1899828	0.1171294	47	13	9.9271466	10.0728534	47
14	9.8101666	9.8827638	0.1898333	0.1172362	46	14	9.9274028	10.0725972	46
15	9.8103159	9.8826568	0.1896841	0.1173432	45	15	9.9276590	10.0723410	45
16	9.8104650	9.8825499	0.1895350	0.1174501	44	16	9.9279152	10.0720848	44
17	9.8106141	9.8824428	0.1893859	0.1175572	43	17	9.9285713	10.0718287	43
18	9.8107631	9.8823357	0.1892369	0.1176643	42	18	9.9284274	10.0715726	42
19	9.8109121	9.8822285	0.1890879	0.1177715	41	19	9.9286835	10.0713165	41
20	9.8110609	9.8821213	0.1889391	0.1178787	40	20	9.9289396	10.0710604	40
21	9.8112096	9.8820140	0.1887904	0.1179860	39	21	9.9291956	10.0708044	39
22	9.8113583	9.8815067	0.1886417	0.1180933	38	22	9.9294516	10.0705484	38
23	9.8115069	9.8817992	0.1884931	0.1182008	37	23	9.9297076	10.0702924	37
24	9.8116554	9.8816918	0.1883446	0.1183082	36	24	9.9299636	10.0700364	36
25	9.8118038	9.8815842	0.1881962	0.1184158	35	25	9.9302195	10.0697805	35
26	9.8119521	9.8814766	0.1880479	0.1185124	34	26	9.9304755	10.0695245	34
27	9.8121003	9.8813689	0.1888997	0.1186311	33	27	9.9307314	10.0692686	33
28	9.8122484	9.8812612	0.1887516	0.1187388	32	28	9.9309872	10.0690128	32
29	9.8123965	9.8811534	0.1886035	0.1188466	31	29	9.9312431	10.0687569	31
30	9.8125444	9.8810455	0.1884556	0.1189545	30	30	9.9314989	10.0685011	30
31	9.8126923	9.8809376	0.1873077	0.1190624	29	31	9.9317547	10.0682453	29
32	9.8128401	9.8808296	0.1871599	0.1192704	28	32	9.9320105	10.0679895	28
33	9.8129878	9.8807215	0.1870122	0.1192785	27	33	9.9322662	10.0677338	27
34	9.8131354	9.8806134	0.1868648	0.1193866	26	34	9.9325220	10.0674780	26
35	9.8132829	9.8805052	0.1867171	0.1194948	25	35	9.9327777	10.0672223	25
36	9.8134303	9.8803970	0.1865697	0.1196030	24	36	9.9330334	10.0669666	24
37	9.8135777	9.8802887	0.1864223	0.1197113	23	37	9.9332890	10.0667110	23
38	9.8137250	9.8801803	0.1862750	0.1198197	22	38	9.9335446	10.0664554	22
39	9.8138721	9.8800719	0.1861279	0.1199281	21	39	9.9338003	10.0661997	21
40	9.8140192	9.8799634	0.1859808	0.1200366	20	40	9.9340559	10.0659441	20
41	9.8141662	9.8798548	0.1858338	0.1201452	19	41	9.9343114	10.0656886	19
42	9.8143131	9.8797462	0.1856869	0.1202538	18	42	9.9345670	10.0654330	18
43	9.8144600	9.8796375	0.1855400	0.1203625	17	43	9.9348225	10.0651775	17
44	9.8146067	9.8795287	0.1853933	0.1204713	16	44	9.9350780	10.0649220	16
45	9.8147534	9.8794199	0.1852466	0.1205801	15	45	9.9353335	10.0646665	15
46	9.8148999	9.8793110	0.1851001	0.1206890	14	46	9.9355889	10.0644111	14
47	9.8150465	9.8792021	0.1849536	0.1207979	13	47	9.5358444	10.0641556	13
48	9.8151928	9.8790930	0.1848072	0.1209070	12	48	9.9360998	10.0639002	12
49	9.8153351	9.8789840	0.1846609	0.1210160	11	49	9.9363552	10.0636448	11
50	9.8154854	9.8788748	0.1845146	0.1211252	10	50	9.9366105	10.0633895	10
51	9.8156314	9.8787656	0.1843685	0.1212344	9	51	9.9368659	10.0631341	9
52	9.8157776	9.8786563	0.1842224	0.1213437	8	52	9.9371212	10.0628788	8
53	9.8159235	9.8785470	0.1830765	0.1214530	7	53	9.9373765	10.0626235	7
54	9.8160694	9.8784376	0.1839306	0.1215624	6	54	9.9376318	10.0623682	6
55	9.8162152	9.8783281	0.1837848	0.1216719	5	55	9.9378871	10.0621129	5
56	9.8163609	9.8782186	0.1836391	0.1217814	4	56	9.9381423	10.0618577	4
57	9.8165066	9.8781090	0.1834934	0.1218910	3	57	9.9383975	10.0616025	3
58	9.8166521	9.8779994	0.1833479	0.1220006	2	58	9.9386527	10.0613473	2
59	9.8167975	9.8778896	0.1832025	0.1221104	1	59	9.9389079	10.0610921	1
60	9.8169429	9.8777799	0.1830571	0.1222201	0	60	9.9391651	10.0608369	0
			Co.Arith.	Sine.				Tangent.	

D.	Sine.	Co. Arith.					Tangent		
0	9.8169429	9.8777799	0.1830571	0.1222201	60	0	9.9391631	10.0608369	60
1	9.8170882	9.8776700	0.1529118	0.1223300	59	1	9.9394182	10.0605818	59
2	9.8172334	9.8775601	0.1827666	0.1224399	58	2	9.9396733	10.0603267	58
3	9.8173785	9.8774501	0.1826215	0.1225499	57	3	9.9399284	10.0600716	57
4	9.8175235	9.8773400	0.1824765	0.1226599	56	4	9.9401835	10.0598165	56
5	9.8176685	9.8772301	0.1823315	0.1227700	55	5	9.9404385	10.0595615	55
6	9.8178133	9.8771198	0.1821867	0.1228802	54	6	9.9406936	10.0593064	54
7	9.8179581	9.8770096	0.1820419	0.1229904	53	7	9.9409486	10.0590514	53
8	9.8181028	9.8768993	0.1818972	0.1231007	52	8	9.9412036	10.0587964	52
9	9.8182474	9.8767889	0.1817526	0.1232111	51	9	9.9414585	10.0585415	51
10	9.8183919	9.8766785	0.1816081	0.1233215	50	10	9.9417135	10.0582865	50
11	9.8185364	9.8765680	0.1814636	0.1234320	49	11	9.9419684	10.0580316	49
12	9.8186807	9.8764574	0.1813193	0.1235426	48	12	9.9422233	10.0577767	48
13	9.8188250	9.8763468	0.1811750	0.1236532	47	13	9.9424782	10.0575218	47
14	9.8189692	9.8762361	0.1810308	0.1237639	46	14	9.9427331	10.0572669	46
15	9.8191133	9.8761253	0.1808867	0.1238747	45	15	9.9429879	10.0570121	45
16	9.8192573	9.8760145	0.1807427	0.1239855	44	16	9.9432428	10.0567572	44
17	9.8194012	9.8759036	0.1805988	0.1240964	43	17	9.9434976	10.0565024	43
18	9.8195450	9.8757927	0.1804550	0.1242073	42	18	9.9437524	10.0562476	42
19	9.8196888	9.8756816	0.1803112	0.1243184	41	19	9.9440072	10.0559928	41
20	9.8198325	9.8755706	0.1801675	0.1244294	40	20	9.9442619	10.0557381	40
21	9.8199761	9.8754594	0.1800239	0.1245406	39	21	9.9445166	10.0554834	39
22	9.8201196	9.8753482	0.1798804	0.1246518	38	22	9.9447714	10.0552286	38
23	9.8202630	9.8752369	0.1797370	0.1247631	37	23	9.9450261	10.0549739	37
24	9.8204063	9.8751256	0.1795937	0.1248744	36	24	9.9452807	10.0547193	36
25	9.8205496	9.8750142	0.1794504	0.1249858	35	25	9.9455354	10.0544646	35
26	9.8206927	9.8749027	0.1793073	0.1250973	34	26	9.9457900	10.0542100	34
27	9.8208358	9.8747912	0.1791642	0.1252088	33	27	9.9460447	10.0539553	33
28	9.8209788	9.8746795	0.1790212	0.1253205	32	28	9.9462993	10.0537007	32
29	9.8211217	9.8745679	0.1788783	0.1254321	31	29	9.9465539	10.0534461	31
30	9.8212646	9.8744561	0.1787354	0.1255439	30	30	9.9468084	10.0531916	30
31	9.8214073	9.8743443	0.1785927	0.1256557	29	31	9.9470630	10.0529370	29
32	9.8215500	9.8742325	0.1784500	0.1257675	28	32	9.9473175	10.0526825	28
33	9.8216926	9.8741205	0.1783074	0.1258795	27	33	9.9475720	10.0524280	27
34	9.8218351	9.8740085	0.1781649	0.1259915	26	34	9.9478265	10.0521735	26
35	9.8219775	9.8738965	0.1780225	0.1261035	25	35	9.9480810	10.0519190	25
36	9.8221198	9.8737844	0.1778802	0.1262156	24	36	9.9483355	10.0516645	24
37	9.8222621	9.8736722	0.1777379	0.1263278	23	37	9.9485899	10.0514101	23
38	9.8224042	9.8735599	0.1775958	0.1264401	22	38	9.9488443	10.0511557	22
39	9.8225463	9.8734496	0.1774537	0.1265524	21	39	9.9490987	10.0509013	21
40	9.8226883	9.8733352	0.1773117	0.1266648	20	40	9.9493531	10.0506469	20
41	9.8228302	9.8732227	0.1771698	0.1267773	19	41	9.9496075	10.0503925	19
42	9.8229721	9.8731102	0.1770279	0.1268898	18	42	9.9498619	10.0501381	18
43	9.8231138	9.8729976	0.1768862	0.1270024	17	43	9.9501162	10.0498838	17
44	9.8232555	9.8728849	0.1767445	0.1271151	16	44	9.9503705	10.0496295	16
45	9.8233971	9.8727722	0.1766029	0.1272278	15	45	9.9506248	10.0493752	15
46	9.8235386	9.8726594	0.1764614	0.1273406	14	46	9.9508791	10.0491209	14
47	9.8236800	9.8725466	0.1763200	0.1274534	13	47	9.5511334	10.0488666	13
48	9.8238213	9.8724337	0.1761787	0.1275663	12	48	9.9513876	10.0486124	12
49	9.8239626	9.8723207	0.1760374	0.1276793	11	49	9.9516419	10.0483581	11
50	9.8241037	9.8722076	0.1758963	0.1277924	10	50	9.9518961	10.0481039	10
51	9.8242448	9.8720945	0.1757552	0.1279055	9	51	9.9521503	10.0478497	9
52	9.8243858	9.8719813	0.1756142	0.1280187	8	52	9.9524045	10.0475955	8
53	9.8245267	9.8718681	0.1754733	0.1281319	7	53	9.9526507	10.0473413	7
54	9.8246676	9.8717548	0.1753324	0.1282451	6	54	9.9529128	10.0470872	6
55	9.8248083	9.8716414	0.1751917	0.1283586	5	55	9.9531670	10.0468330	5
56	9.8249490	9.8715279	0.1750510	0.1284721	4	56	9.9534211	10.0465789	4
57	9.8250896	9.8714144	0.1749104	0.1285856	3	57	9.9536752	10.0463248	3
58	9.8252301	9.8713008	0.1747699	0.1286992	2	58	9.9539292	10.0460707	2
59	9.8253705	9.8711872	0.1746295	0.1288128	1	59	9.9541834	10.0458166	1
60	9.8255109	9.8710735	0.1744891	0.1289265	0	60	9.9544374	10.0455626	0
			Co.Arith.	Sine.				Tangent.	

Degrees. 42.

D.	Sine.	Co. Arith.				D.	Tangent		
0	9.8255109	9.8710735	0.1744891	0.1289265	60	0	9.9544374	10.0455626	60
1	9.8256512	9.8709597	0.1743488	0.1290403	59	1	9.9546915	10.0453085	59
2	9.8257913	9.8708458	0.1742087	0.1291542	58	2	9.9549455	10.0450545	58
3	9.8259314	9.8707319	0.1740686	0.1292681	57	3	9.9551995	10.0448005	57
4	9.8250715	9.8706179	0.1739285	0.1293821	56	4	9.9554535	10.0445465	56
5	9.8262114	9.8705039	0.1737886	0.1294961	55	5	9.9557075	10.0442925	55
6	9.8263512	9.8703898	0.1736488	0.1296102	54	6	9.9559615	10.0440385	54
7	9.8264910	9.8702756	0.1735090	0.1297244	53	7	9.9562154	10.0437846	53
8	9.8266307	9.8701613	0.1733693	0.1298387	52	8	9.9564694	10.0435306	52
9	9.8267703	9.8700470	0.1732297	0.1299530	51	9	9.9567233	10.0432767	51
10	9.8269098	9.8699326	0.1730902	0.1300674	50	10	9.9569772	10.0430228	50
11	9.8270493	9.8698182	0.1729507	0.1301818	49	11	9.9572311	10.0427689	49
12	9.8271887	9.8697037	0.1728113	0.1302963	48	12	9.9574850	10.0425150	48
13	9.8273279	9.8695891	0.1726721	0.1304109	47	13	9.9577389	10.0422611	47
14	9.8274671	9.8694744	0.1725329	0.1305256	46	14	9.9579927	10.0420073	46
15	9.8276063	9.8693597	0.1723937	0.1306403	45	15	9.9582465	10.0417535	45
16	9.8277453	9.8692449	0.1722547	0.1307511	44	16	9.9585004	10.0414996	44
17	9.8278843	9.8691301	0.1721157	0.1308699	43	17	9.9587542	10.0412458	43
18	9.8280231	9.8690152	0.1719769	0.1309848	42	18	9.9590080	10.0409920	42
19	9.8281619	9.8689002	0.1718381	0.1310998	41	19	9.9592618	10.0407382	41
20	9.8283006	9.8687851	0.1716994	0.1312149	40	20	9.9595155	10.0404845	40
21	9.8284393	9.8686700	0.1715607	0.1313300	39	21	9.9597693	10.0302307	39
22	9.8285778	9.8685548	0.1714222	0.1314452	38	22	9.9600230	10.0399770	38
23	9.8287163	9.8684396	0.1712837	0.1315604	37	23	9.9602767	10.0397232	37
24	9.8288547	9.8683242	0.1711453	0.1316758	36	24	9.9605305	10.0394695	36
25	9.8289930	9.8682088	0.1710070	0.1317912	35	25	9.9607842	10.0392158	35
26	9.8291312	9.8680934	0.1708688	0.1319066	34	26	9.9610378	10.0389622	34
27	9.8292694	9.8679779	0.1707306	0.1320221	33	27	9.9612915	10.0387085	33
28	9.8294075	9.8678623	0.1705925	0.1321377	32	28	9.9615452	10.0384548	32
29	9.8295454	9.8677466	0.1704546	0.1322534	31	29	9.9617988	10.0382012	31
30	9.8296833	9.8676309	0.1703167	0.1323691	30	30	9.9620525	10.0379475	30
31	9.8298212	9.8675151	0.1701788	0.1324849	29	31	9.9623061	10.0376939	29
32	9.8299589	9.8673992	0.1700411	0.1326008	28	32	9.9625597	10.0374403	28
33	9.8300966	9.8672833	0.1699035	0.1327167	27	33	9.9628133	10.0371867	27
34	9.8302342	9.8671673	0.1697658	0.1328327	26	34	9.9630669	10.0369331	26
35	9.8303717	9.8670512	0.1696283	0.1329488	25	35	9.9633204	10.0366796	25
36	9.8305091	9.8669351	0.1694909	0.1330649	24	36	9.9635740	10.0364260	24
37	9.8306464	9.8668189	0.1693536	0.1331811	23	37	9.9638275	10.0361725	23
38	9.8307837	9.8667026	0.1692163	0.1332974	22	38	9.9640811	10.0359189	22
39	9.8309209	9.8665863	0.1690791	0.1334137	21	39	9.9643346	10.0356654	21
40	9.8310580	9.8664699	0.1689420	0.1335301	20	40	9.9645881	10.0354119	20
41	9.8311950	9.8663534	0.1688050	0.1336466	19	41	9.9648416	10.0351584	19
42	9.8313320	9.8662369	0.1686680	0.1337631	18	42	9.9650951	10.0349049	18
43	9.8314688	9.8661203	0.1685312	0.1338797	17	43	9.9653486	10.0346514	17
44	9.8316056	9.8660036	0.1683944	0.1339964	16	44	9.9656020	10.0343980	16
45	9.8317423	9.8658868	0.1782577	0.1341132	15	45	9.9658555	10.0341445	15
46	9.8318789	9.8657700	0.1681211	0.1342300	14	46	9.9661089	10.0338911	14
47	9.8320155	9.8656531	0.1679845	0.1343469	13	47	9.5663623	10.0336377	13
48	9.8321519	9.8655362	0.1678481	0.1344638	12	48	9.9666157	10.0333843	12
49	9.8322883	9.8654192	0.1677117	0.1345808	11	49	9.9668692	10.0331308	11
50	9.8324246	9.8653021	0.1675754	0.1346979	10	50	9.9671225	10.0328775	10
51	9.8325609	9.8651849	0.1674391	0.1348151	9	51	9.9673759	10.0326241	9
52	9.8326970	9.8650677	0.1673030	0.1349323	8	52	9.9676293	10.0323707	8
53	9.8328331	9.8659504	0.1671669	0.1350496	7	53	9.9678827	10.0321173	7
54	9.8329691	9.8648331	0.1670309	0.1351669	6	54	9.9081360	10.0318640	6
55	9.8331050	9.8647156	0.1668950	0.1352844	5	55	9.9683893	10.0315107	5
56	9.8332408	9.8645981	0.1667592	0.1354019	4	56	9.9686427	10.0313573	4
57	9.8333766	9.8644806	0.1666234	0.1355194	3	57	9.9688960	10.0311040	3
58	9.8335122	9.8643629	0.1664878	0.1356371	2	58	9.9691493	10.0308507	2
59	9.8336478	9.8642452	0.1663522	0.1357548	1	59	9.9694026	10.0305974	1
60	9.8337833	9.8641275	0.1662167	0.1358725	0	60	9.9696559	10.0303441	0
			Co.Arith.	Sine.				Tangent.	

Degrees 47.

Degrees 43.

D.	Sine.	Co.Arith.				D.	Tangent.		
0	9.8337833	9.8541275	0 1562167	0.1358725	60	0	9.9696559	10.0303441	60
1	9.8339188	9.8640096	0.1660812	0.1359904	59	1	9.9699091	10.0300909	59
2	9.8340541	9.8638917	0 1659459	0.1361083	58	2	9.9701624	10.0298376	58
3	9.8341894	9.8637737	0.1658106	0.1362263	57	3	9.9704157	10.029[illegible]843	57
4	9.8343246	9.8636557	0.1656734	0.1363443	56	4	9.9706689	10.0293311	56
5	9.8344597	9 8635376	0.1655403	0.1364624	55	5	9.9709221	10.0290779	55
6	9.8345978	9.86[illegible]4194	0.1654052	0.1365806	54	6	9.9711754	10.0288240	54
7	9.8347297	9.8633011	0.1652703	0.2366989	53	7	9.9714286	10.0285714	53
8	9.8348646	9.8631828	0.1651354	0.1368172	52	8	9.9716818	10.0283182	52
9	9.8349994	9.8630644	0.1650006	0.1369356	51	9	9.9719350	10.0280650	51
10	9.8351341	9.8629460	0.1648659	0.1370540	50	10	9.9721882	10.0278118	50
11	9.8352688	9.8628274	0.1647312	0.1371726	49	11	9.9724413	10.0275587	49
12	9.8354033	9.8627088	0.1645967	0.1372912	48	12	9.9726945	10.0273055	48
13	9.8355378	9.8625902	0.1644622	0.1374098	47	13	9.9729477	10.0270523	47
14	9.8356722	9.8624714	0.1643278	0.1375286	46	14	9.9732008	10.0267992	46
15	9.8358066	9.8623526	0.1641934	0.1376474	45	15	9.9734539	10.0265461	45
16	9.8359408	9.8622338	0.1640592	0.1377662	44	16	9.9737071	10.0262929	44
17	9.8360750	9.8621148	0.1629250	0.1378852	43	17	9.9739602	10.0260398	43
18	9.8362091	9.8519958	0.1637909	0.1370042	42	18	9.9742133	10.0257867	42
19	9.8363431	9.8618767	0.1636569	0.1381233	41	19	9.9744664	10.0255336	41
20	9.8364771	9.8617576	0.1635229	0.1382424	40	20	9.9747195	10.0252805	40
21	9.8366109	9.8616383	0.1633891	0.1383617	39	21	9.9749726	10.0250274	39
22	9.8367447	9.8615190	0.1632553	0.1384810	38	22	9.9752257	10.0247743	38
23	9.8368784	9.8613997	0.1631216	0.1386003	37	23	9.9754787	10.0245213	37
24	9.8370121	9.8612802	0.1629879	0.1387197	36	24	9.9757318	10.0242682	36
25	9.8371456	9.8611608	0.1628544	0.1388392	35	25	9.9759849	10.0240151	35
26	9.8372791	9.8610412	0.1627209	0.1389588	34	26	9.9762379	10.0237621	34
27	9.8374125	9.8609215	0.1625875	0.1390785	33	27	9.9764909	10.0235091	33
28	9.8375458	9.8608018	0.1624542	0.1391982	32	28	9.9767440	10.0232560	32
29	9.8376790	9.8606821	0.1623210	0.1393179	31	29	9.9769970	10.0230030	31
30	9.8378122	9.8605622	0.1621878	0.1394378	30	30	9.9772500	10.0227500	30
31	9.8379453	9.8604423	0.1620547	0.1395577	29	31	9.9775030	10.0224970	29
32	9.8380783	9.8603223	0.1619217	0.1396777	28	32	9.9777560	10.0222440	28
33	9.8382112	9.8602022	0.1617888	0.1397978	27	33	9.9780090	10.0229910	27
34	9.8383441	9.8600821	0.1616559	0.1399179	26	34	9.9782620	10.0217380	26
35	9.83847[illegible]9	9.8599619	0.1615231	0.1400381	25	35	9.9785149	10.0214851	25
36	9.8386096	9.8598416	0.1613094	0.1401584	24	36	9.9787679	10.0212321	24
37	9.8387422	9.8597213	0.1612578	0.1402787	23	37	9.9790209	10.0209791	23
38	9.8388747	9.8596009	0.1611253	0.1403991	22	38	9.9792738	10.0207262	22
39	9.8390072	9.8594804	0.1609928	0.1405196	21	39	9.9795268	10.0204732	21
40	9.8391396	9.8593599	0.1608604	0.1406401	20	40	9.9797797	10.0202203	20
41	9.8392719	9.8592393	0.1607281	0.1407607	19	41	9.9800326	10.0199674	19
42	9.8394041	9.8591186	0.1605959	0.1408814	18	42	9.9802856	10.0197144	18
43	9.8395363	9.8589978	0.1604637	0.1410022	17	43	9.9805385	10.0194615	17
44	9.8396684	9.8588770	0.1603316	0.1411230	16	44	9.9807914	10.0192086	16
45	9.8398004	9.8587561	0.1601996	0.1412439	15	45	9.9810443	10.0189557	15
46	9.8399323	9.8586351	0.1600677	0.1413649	14	46	9.9812972	10.0187028	14
47	9.8400642	9.8585141	0.1599358	0.1414859	13	47	9.9815501	10.0184499	13
48	9.8401959	9.8583929	0.1598041	0.1416071	12	48	9.9818030	10.0181970	12
49	9.8403276	9.8582718	0.1596724	0.1417282	11	49	9.9820559	10.0179441	11
50	9.8404563	9.8581503	0.1595407	0.1418495	10	50	9.9823087	10.0176913	10
51	9.8405908	9.8580292	0.1594092	0.1419708	9	51	9.9825616	10.0174384	9
52	9.8407223	9.8579078	0.1592777	0.1420922	8	52	9.9828145	10.0171855	8
53	9.8408537	9.8517863	0.1591463	0.1422137	7	53	9.9830673	10.0169327	7
54	9.8409850	9.8576648	0.1590150	0.1423353	6	54	9.9833202	10.0166798	6
55	9.8411162	9.8575432	0.1588838	0.1424568	5	55	9.9835730	10.0164270	5
56	9.8412474	9.8574215	0.1587526	0.1425785	4	56	9.9838259	10.0161741	4
57	9.841378[illegible]	9.8572998	0.1586215	0.1427002	3	57	9.9840787	10.0159213	3
58	9.3415095	9.8571779	0.1584905	0.1428221	2	58	9.9843315	10.0156685	2
59	9.8416404	9.8570561	0.1583596	0.1429439	1	59	9.9845844	10.0154156	1
60	9.8417713	9.8569381	0.1582287	0.1430659	0	60	9.9848372	10.0151628	0
			Co.Arith.	Sine.				Tangent.	

Degrees 46.

Degrees 44.

D.	Sine.	Co.Arith.				D.	Tangent.		
0	9.8417713	9.8569341	0.1582287	0.1430659	60	0	9.9848372	10.0151628	60
1	9.8419021	9.8568121	0.1580979	0.1431879	59	1	9.9850900	10.0149100	59
2	9.8420328	9.8566900	0.1579672	0.1433100	58	2	9.9853428	10.0146572	58
3	9.8421634	9.8565678	0.1578366	0.1434322	57	3	9.9855956	10.0144044	57
4	9.8422939	9.8564455	0.1577061	0.1435545	56	4	9.9858484	10.0141516	56
5	9.8424244	9.8563232	0.1575756	0.1436768	55	5	9.9861012	10.0138988	55
6	9.8425548	9.8562008	0.1574452	0.1437992	54	6	9.9863540	10.0136460	54
7	9.8426851	9.8560784	0.1573149	0.1439216	53	7	9.9866068	10.0133932	53
8	9.8428154	9.8559558	0.1571846	0.1440442	52	8	9.9868596	10.0131404	52
9	9.8429456	9.8558332	0.1570544	0.1441668	51	9	9.9871123	10.0128877	51
10	9.8430757	9.8557106	0.1569243	0.1442894	50	10	9.9873651	10.0126349	50
11	9.8432057	9.8555878	0.1567943	0.1444122	49	11	9.9876179	10.0123821	49
12	9.8433356	9.8554650	0.1566644	0.1445350	48	12	9.9878706	10.0121294	48
13	9.8434655	9.8553421	0.1565345	0.1446579	47	13	9.9881234	10.0118766	47
14	9.8435953	9.8552192	0.1564047	0.1447808	46	14	9.9883761	10.0116239	46
15	9.8437250	9.8550961	0.1562750	0.1449039	45	15	9.9886289	10.0113711	45
16	9.8438547	9.8549730	0.1561453	0.1450270	44	16	9.9888816	10.0111184	44
17	9.8439842	9.8548499	0.1560158	0.1451501	43	17	9.9891344	10.0108656	43
18	9.8441137	9.8547266	0.1558863	0.1452734	42	18	9.9893871	10.0106129	42
19	9.8442432	9.8546033	0.1557568	0.1453967	41	19	9.9896399	10.0103601	41
20	9.8443725	9.8544799	0.1556275	0.1455101	40	20	9.9898926	10.0101074	40
21	9.8445015	9.8543564	0.1554982	0.1456436	39	21	9.9901453	10.0098547	39
22	9.8446310	9.8542329	0.1553690	0.1457671	38	22	9.9903981	10.0096019	38
23	9.8447601	9.8541093	0.1552399	0.1458907	37	23	9.9906508	10.0093492	37
24	9.8448891	9.8539856	0.1551109	0.1460144	36	24	9.9909035	10.0090965	36
25	9.8450181	9.8538619	0.1549819	0.1461381	35	25	9.9911562	10.0088438	35
26	9.8451470	9.8537381	0.1548530	0.1462619	34	26	9.9914089	10.0085911	34
27	9.8452758	9.8536142	0.1547242	0.1463858	33	27	9.9916616	10.0083384	33
28	9.8454045	9.8534902	0.1545955	0.1465098	32	28	9.9919143	10.0080857	32
29	9.8455332	9.8533662	0.1544668	0.1466338	31	29	9.9921670	10.0078330	31
30	9.8456618	9.8532421	0.1543382	0.1467579	30	30	9.9924197	10.0075803	30
31	9.8457903	9.8531179	0.1542097	0.1468821	29	31	9.9926724	10.0073276	29
32	9.8459188	9.8529936	0.1540812	0.1470064	28	32	9.9929251	10.0070749	28
33	9.8460471	9.8528693	0.1539529	0.1471307	27	33	9.9931778	10.0068222	27
34	9.8461754	9.8527449	0.1538246	0.1472551	26	34	9.9934305	10.0065695	26
35	9.8463036	9.8526204	0.1536964	0.1473796	25	3[illegible]	[illegible].9936832	10.0063168	25
36	9.8464318	9.8524959	0.1535682	0.1475041	24	36	9.9939359	10.0060641	24
37	9.8465599	9.8523713	0.1534401	0.2476287	23	37	9.9941886	10.0058114	23
38	9.8466879	9.8522465	0.1533121	0.1477534	22	38	9.9944413	10.0055587	22
39	9.8468150	9.8521218	0.1531842	0.1478782	21	39	9.9946940	10.0053060	21
40	9.8469436	9.8519970	0.1530564	0.1480030	20	40	9.9949466	10.0050534	20
41	9.8470714	9.8518721	0.1529287	0.1481279	19	41	9.9951993	10.0048007	19
42	9.8471991	9.8517471	0.1528009	0.1482529	18	42	9.9954520	10.0045480	18
43	9.8473267	9.8516220	0.1526733	0.1483780	17	43	9.9957047	10.0042953	17
44	9.8474543	9.8514969	0.1525457	0.1485031	16	44	9.9959573	10.0040427	16
45	9.8375817	9.8513717	0.1524183	0.1486283	15	45	9.9962100	10.0037900	15
46	9.8477091	9.8512465	0.1522909	0.1487535	14	46	9.9964627	10.0035373	14
47	9.8478365	9.8511211	0.1521635	0.1488789	13	47	9.9967154	10.0032846	1[illegible]
48	9.8479637	9.8509957	0.1520363	0.1490043	12	48	9.9969680	10.0630320	12
49	9.8480909	9.8508702	0.1519091	0.1491298	11	49	9.9972207	10.0027793	11
50	9.8482180	9.8507446	0.1517820	0.1492554	10	50	9.9974734	10.0025266	10
51	9.8483450	9.8506190	0.1516550	0.1493810	9	51	9.9977260	10.0022740	9
52	9.8484720	9.8504933	0.1515280	0.1495067	8	52	9.9989787	10.0020213	8
53	9.8485989	9.8503675	0.1514011	0.1496325	7	53	9.9982314	10.0017686	7
54	9.8487257	9.8502417	0.1512743	0.1497583	6	54	9.9984840	10.0015160	6
55	9.8488524	9.8501157	0.1511476	0.1498843	5	55	9.9987367	10.0012633	5
56	9.8489791	9.8499897	0.1510209	0.1590103	4	56	9.9989893	10.0010107	4
57	9.8491057	9.8498637	0.1508943	0.1501363	3	57	9.9992420	10.0007580	3
58	9.3492322	9.8497375	0.1507678	0.1502625	2	58	9.[illegible]964947	10.0005053	2
59	9.8493586	9.8496113	0.1506414	0.1503887	1	59	9.9997473	10.0002527	1
60	9.8494850	9.8494850	0.1505150	0.1505150	0	60	1.0000000	10.0000000	0
			Co.Arith.	Sine.				Tangent.	

Degrees 45.